Recycling: theory and reality

Seeta Sharma

University of Wollongong

1995

UNIVERSITY OF WOLLONGONG

COPYRIGHT WARNING

You may print or download ONE copy of this document for the purpose of your own research or study. The University does not authorise you to copy, communicate or otherwise make available electronically to any other person any copyright material contained on this site. You are reminded of the following:

This work is copyright. Apart from any use permitted under the Copyright Act 1968, no part of this work may be reproduced by any process, nor may any other exclusive right be exercised, without the permission of the author.

Copyright owners are entitled to take legal action against persons who infringe their copyright. A reproduction of material that is protected by copyright may be a copyright infringement. A court may impose penalties and award damages in relation to offences and infringements relating to copyright material. Higher penalties may apply, and higher damages may be awarded, for offences and infringements involving the conversion of material into digital or electronic form.

Unless otherwise indicated, the views expressed in this thesis are those of the author and do not necessarily represent the views of the University of Wollongong.

Recommended Citation


Research Online is the open access institutional repository for the University of Wollongong. For further information contact the UOW Library: research-pubs@uow.edu.au
RECYCLING : THEORY AND REALITY


by

Seeta Sharma

A thesis submitted in fulfilment for the requirements of a Masters of Arts Honours Degree in the Department of Geography, The University of Wollongong, 1995.
ABSTRACT

Humans have dumped, burned, and reused refuse in primary and modern societies. Today, with increasing environmental consciousness, resource recovery options like incineration, pyrolysis and recycling are coming up as new methods of waste disposal. Recycling is increasingly being regarded as the preferable option of disposing waste for the promise it brings of saving resources and energy and reducing pollution. Though many of the factors associated with recycling are of social or environmental factors, attention is normally focussed on the more tangible, economic aspects of the method. This thesis establishes a broad framework which lays the criteria for assessing the method on the basis of economic, socio-political and environmental factors. However, being relatively new, there are no proven theories about recycling and various services need to be evaluated to establish any conclusions about the method. The Wollongong City Council Domestic Waste Recycling Service is evaluated to determine the factors that affect recycling and to provide more information about the method.
ACKNOWLEDGMENTS

There are many people to whom I am greatly indebted for help, guidance and assistance during the process of the thesis.

* John Formby, my Supervisor for his suggestions, kindness and patience. For always being supportive and for reading the drafts.

* Rick Jones at the Wollongong City Council for his co-operation in providing information, guidance and assistance.

* The staff of the Geography Department at University of Wollongong, especially Dr. Gerald Nanson, Dr. Laurie Brown and Dr. Lesley Head.

* John Marthick and Dhammika Ruberu for technical assistance.


* Very specially to Bronwyn Seaborn, Chris Mar, Cynthia Halloran, Deb Atkinson, Sonja Schuh, Udai Singh and all others at I-House who helped me with some very trying times. Without their encouragement and constant support I would never have stayed on to finish this degree.

* My parents and sister who have been extremely understanding and supportive and provided me with the opportunity to do this degree in Australia.
## CONTENTS

Abstract ......................................................... i
Acknowledgments ........................................... ii
Table of Contents ......................................... iii
List of Tables .................................................. vii
List of Plates .................................................. viii
List of Figures ................................................ ix
Glossary .......................................................... xi

### CHAPTER 1: INTRODUCTION

1.1 Introduction ............................................... 1
1.2 Project Outline ........................................... 1
1.3 Objectives .................................................. 2
1.4 Thesis Outline ............................................ 3

### CHAPTER 2: RECYCLING: PROMISES AND PROBLEMS

2.1 Introduction ............................................... 4
2.2 Economics .................................................. 4
2.2.1 Plant Establishment and Maintenance Costs .......................... 4
2.2.2 Comparison of Methods of Waste Disposal ........................ 5
2.2.3 Collection and Sorting Costs ................................... 7
2.2.3.i Site location and transportation costs .......................... 7
2.2.3.ii Storage .................................................. 8
2.2.4 Smaller Waste Stream ....................................... 8
2.2.5 Risk ....................................................... 10
CHAPTER 3: HISTORY OF RECYCLING

3.1 Introduction 41
3.2 Recycling in Australia 41
3.3 Recycling in NSW 47
3.4 Recycling in Wollongong 52
3.4.1 History of recycling 52
3.4.2 Reasons for introduction of the 1994 Recycling Program 55
3.4.3 Present Program 57
3.5 Conclusion 58
### CHAPTER 4: EVALUATION OF THE WOLLONGONG CITY COUNCIL DOMESTIC WASTE RECYCLING PROGRAM

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1</td>
<td>Introduction</td>
<td>60</td>
</tr>
<tr>
<td>4.2</td>
<td>Economics</td>
<td>60</td>
</tr>
<tr>
<td>4.2.1</td>
<td>Risk</td>
<td>60</td>
</tr>
<tr>
<td>4.2.2</td>
<td>Capital</td>
<td>61</td>
</tr>
<tr>
<td>4.2.3</td>
<td>Maintenance Cost</td>
<td>62</td>
</tr>
<tr>
<td>4.2.4</td>
<td>Collection and Transportation</td>
<td>63</td>
</tr>
<tr>
<td>4.2.5</td>
<td>Market</td>
<td>65</td>
</tr>
<tr>
<td>4.2.5.i</td>
<td>Demand</td>
<td>65</td>
</tr>
<tr>
<td>4.2.5.ii</td>
<td>Supply</td>
<td>65</td>
</tr>
<tr>
<td>4.2.6</td>
<td>Storage</td>
<td>67</td>
</tr>
<tr>
<td>4.2.7</td>
<td>Balance of Trade</td>
<td>68</td>
</tr>
<tr>
<td>4.3</td>
<td>Socio-Political</td>
<td>69</td>
</tr>
<tr>
<td>4.3.1</td>
<td>Image</td>
<td>69</td>
</tr>
<tr>
<td>4.3.1.i</td>
<td>Contractor</td>
<td>69</td>
</tr>
<tr>
<td>4.3.1.ii</td>
<td>Government</td>
<td>69</td>
</tr>
<tr>
<td>4.3.1.iii</td>
<td>Industry</td>
<td>70</td>
</tr>
<tr>
<td>4.3.2</td>
<td>Participation</td>
<td>70</td>
</tr>
<tr>
<td>4.3.2.i</td>
<td>Society</td>
<td>70</td>
</tr>
<tr>
<td>4.3.2.ii</td>
<td>Individuals</td>
<td>71</td>
</tr>
<tr>
<td>4.3.3</td>
<td>Source Separation</td>
<td>73</td>
</tr>
<tr>
<td>4.3.4</td>
<td>Technical</td>
<td>74</td>
</tr>
</tbody>
</table>
LIST OF TABLES

2.1  Comparative Economics of Waste Disposal.                      6
2.2  Australia: Savings from Recycling, 1989.                       9
2.3  Comparison of awareness of recycling to recycling rates       26
2.4  Energy reduction derived from substituting secondary materials for virgin resources.  35
2.5  Environmental benefits derived from substituting secondary materials for virgin resources.  37
3.1  Method of Waste Disposal by Councils, 1989.                   43
3.2  Recycling rates and targets achieved.                        44
3.3  Comparison of Australian Consumption with materials recovered from participating households.  45
3.4  Recycling potential of NSW domestic waste                    50
3.5  households serviced by house-to-house collections            52
4.1  Materials recycled, July-December, 1994.                      87
4.2  Comparison of total waste collection before and after the new recycling service.          90
4.3  Percentage of energy saved as a result of using recycled material.                        96
<table>
<thead>
<tr>
<th>Plate</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1</td>
<td>Contaminated bottles ready for delivery</td>
<td>74</td>
</tr>
<tr>
<td>4.2</td>
<td>Manual sorting of different coloured glass at the MRF</td>
<td>77</td>
</tr>
<tr>
<td>4.3</td>
<td>Mechanical arm leading to single side collection from kerbs.</td>
<td>98</td>
</tr>
<tr>
<td>4.4</td>
<td>Location site prior to construction of the MRF.</td>
<td>99</td>
</tr>
<tr>
<td>4.5</td>
<td>Location site after construction of the MRF.</td>
<td>99</td>
</tr>
</tbody>
</table>
LIST OF FIGURES

2.1 The efficient level of recycling. 14
2.2 The Anthroposystem as propounded by Santos. 32
3.1 Method of waste disposal by Councils, 1989. 42
3.2 Method of waste disposal in NSW. 48
3.3 NSW waste management hierarchy. 49
4.1 Map indicating the North/South city divide and site of tip and MRF. 64
4.2 Sketch of the recycling plant showing storage space. 67
4.3 Amount of recycled material collected quarterly from 1991/92 to 1994/95. 71
4.4 Cross-section of the recycling bin indicating the gap at the bottom causing contamination. 75
4.5 Map showing the number of graduates and diplomates in Wollongong. 79
4.6 Map showing the proportion of overseas and English speaking overseas population in Wollongong. 80
4.7 Materials recycled July-December, 1994. 88
4.8 Comparison of total waste collected before and after the new recycling service. 91
4.9 Cumulative amount of garbage entering the tip. 93
GLOSSARY

BUY-BACK CENTER - A centre where people receive money for
returning their recyclables

DOMESTIC SOLID WASTE - All non-sewage household wastes.

HDPE - High Density polyethylene.

LIQUIDPAPERBOARD - Paper cartons used for packaging milk and
juices etc.

MRF - Material Recycling Facility.

PET - Polyethylene terephthalate.

 PICKERS/ SORTERS - People at the MRF who sort garbage.
CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION

Over the last twenty years, humans have become increasingly aware of their relationship with the environment (Markandya and Richardson, 1992). They have realised that because of their dominance over nature they have to make choices for balancing the human-environmental relationship (Ward, 1979; Barbour, 1980). One such choice is in the aspect of waste disposal. It is at this stage of growing environmental consciousness that recycling is increasingly being considered as a possible solution to the waste disposal problem. The aim of this research is to explore the suitability of the method to provide some direction in the sphere of solid waste disposal.

1.2 PROJECT OUTLINE

To assess recycling, a case study of the Wollongong City Council Domestic Waste Recycling Program was executed. However, prior to its evaluation, a broad framework had to be established because though several hypothesis and ideas are present regarding the method, there is no theory or holistic framework that is available for evaluating recycling in its totality. The program is evaluated on the basis of the framework that is established in the thesis. The assessment of this recycling program provides an example of the various factors that do effect recycling in reality, rather than in theory alone. It also provides suggestions for improvement of the Wollongong Recycling Service and establishes greater certainty about the promises and problems established in the framework.
1.3 OBJECTIVES

While assessing recycling as a method of solid waste disposal, the following aims were fulfilled.

1) Establishment of a trans disciplinary framework to provide a broader perspective for evaluating recycling.

2) Understand the significance of all factors in creating a framework viz. economic, socio-political and environmental in comparison to a framework of one category.

3) To incorporate the history of the country and the state of NSW to understand the relation and effect of national and state policies on local areas.

4) Understand the changes in recycling over the years in Wollongong and the affect of previous experiences on the present service.

5) Evaluation of recycling in Wollongong on the basis of the framework established.

6) Examine the failure and success of the Wollongong recycling program and relate it to the previously established framework.

7) Provide suggestions for improvement of the Wollongong Program and recommendations for other services.
1.4 THESIS OUTLINE

Chapter 2 discusses the three main factors - economic, socio-political and environmental that are associated with recycling under the heading of "promises and problems". This provides a framework for the evaluation of the method.

Chapter 3 is a brief history of recycling in Australia and NSW to provide a background for recycling in Wollongong. Recycling in Wollongong is discussed in detail since it leads up to the present recycling service which is the case study of this thesis.

Chapter 4 evaluates the Wollongong City Council Domestic Waste Recycling Program. This evaluation is done on the basis of the framework previously established in chapter 2. It also provides proposals for improvement of the recycling service in Wollongong.

The findings of this thesis are summarised in Chapter 5 with recommendations to be taken into consideration while establishing future recycling services or improving already existing services. Suggestions for further research are also addressed.
Chapter 2: RECYCLING: PROMISES AND PROBLEMS

2.1 INTRODUCTION

There are several factors, both positive and negative that affect a waste disposal method. This chapter discusses the factors that determine decisions on recycling as promises and problems. By focussing on the promises and problems, a broader picture of recycling is established. These are discussed under economic, social-political and environmental factors because these are the three main reasons that effect recycling.

2.2 ECONOMICS

The economic costs associated with recycling are tangible, easier to assess and normally dominate the evaluation of such activities.

2.2.1 Plant Establishment and Maintenance Costs

Resource recovery often tends to be more costly than traditional disposal methods, especially in the initial years of operation. The recycling plant requires high capital outlay and operating, overhead and maintenance costs also tend to be high (Kinney, 1979; Alter, 1979). Being labour intensive, it requires sorting and processing and thus can turn out to be more expensive in countries where labour costs are high.

Segregating recyclables from the waste stream, then processing them into useable form poses one of the most basic of all problems associated with recycling. It requires an infrastructure of institutions
and practises in municipalities, secondary materials processors and brokers, and basic material processors. The infrastructure is complex; growth among the various institutions needs to be coordinated. Building such systems takes time and money (Erwin and Healy, 1990).

It is also important to remember that waste is generated on a regular basis, all sorts of problems, usually costly to remedy, can arise if there is any serious delay in processing it (Wilcox, 1976).

Such factors can be an impediment to recycling for it can hardly ever be a small scale industry if it requires such a sophisticated infrastructure and high capital expenditure. Large scale industries require more time to establish. Also being fewer in number, their effect is restricted. As a result recycling spreads slowly.

2.2.2 Comparison of Methods of Waste Disposal

A benefit of recycling is that it avoids the use of other disposal methods, which are common but perhaps not as environmentally-friendly as recycling eg landfill and incineration (Erwin and Healy, 1990). As an example, the following table can be taken into consideration.
<table>
<thead>
<tr>
<th>System Concept</th>
<th>Investment</th>
<th>Total Annual Cost</th>
<th>Resource Value</th>
<th>Net Annual Cost</th>
<th>Net Cost / Input Ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incineration</td>
<td>$9,299</td>
<td>$2,303</td>
<td>$0</td>
<td>$2,303</td>
<td>$7.68</td>
</tr>
<tr>
<td>Pyrolysis</td>
<td>$12,334</td>
<td>$3,287</td>
<td>$1,661</td>
<td>$1,626</td>
<td>$5.42</td>
</tr>
<tr>
<td>Materials Recovery</td>
<td>$11,568</td>
<td>$2,759</td>
<td>$1,328</td>
<td>$1,431</td>
<td>$4.77</td>
</tr>
<tr>
<td>Sanitary Landfill</td>
<td>$2,472</td>
<td>$770</td>
<td>$0</td>
<td>$770</td>
<td>$2.57</td>
</tr>
</tbody>
</table>

Summary of system economics based on municipally owned, 1000-ton/day plant with 20-year economic life, operating 300 days/year.

Source: Midwest Research Institute in GEC, 1975

Table 2.1: Comparative Economics of Waste Disposal

Though the table above is dated 1975 because no recent information of the kind was available, it is significant even today. During the 20 year period, all costs rose. Resource value also rose but considerably faster than other values. This is because resource value depends upon virgin ore amounts and since these have reduced rapidly over the last two decades, demand for recycled materials has increased considerably and consequently the value of resource recovery has also increased (Lynch, 1981; Butlin, 1976).

From the table it can be seen that though investment costs are high, the net cost of a resource recovery scheme is lower than other processes like incineration or pyrolysis. On the other hand, it is more expensive than landfill. However, landfill does not have any resource value and with expected increases in resource value in the future, it can be concluded that resource recovery would be preferable. Even if landfill continues to be lower in costs to resource recovery, there are other socio-political and environmental factors that favour recycling. These are discussed later in the environmental and socio-political sections of this chapter.
2.2.3 Collection and Sorting Costs

2.2.3.i Site Location and Transportation Costs

Transportation and collection costs determine the feasibility of recycling to a great extent. In fact collection is now becoming more critical because of the high operational cost of fuel and labour (Nemerow, 1984). Any small percentage improvement in the collection operation will result in significant savings in the overall daily cost associated with recycling (ibid).

It is important to recognise that because recycled material is often relatively low in value per tonne, the cost of actually transporting that material has to be kept at an absolute minimum (Ashworth, 1992). Poorly sited facilities can create more nuisance than the actual process is worth. People bringing their material to the recycling centre could end up wasting more energy in the process than would eventually be recovered (ibid). There are also delivery costs associated with transportation for the collected goods have to be taken to the market (Vogler, 1981). In fact the cost of transportation may determine which sources of supply or markets are economic (ibid).

At the same time because goods are recycled and not 'dumped', they have return value. Such returns have to be taken into consideration when calculating recycling costs in comparison to transportation and collection costs of the same material as waste. Thus though transport costs are to be minimal, returns gained from recovered materials indicate that recycling can bear some increase in transportation and collection costs.
2.2.3.ii Storage

Though storage is not a desirable long-term option for waste management, there must be adequate place for storage. This is to accommodate for the expected time lapse between collection and transportation of material to the industry (WMANSW, c1990). Material is often collected at recycling facilities for processing and sorting before it can be sent to the market and thus has to be stored. Premises and storage are usually necessary for all but the smallest waste collections (Vogler, 1981). Often material needs to be stored for a few days before it is in sufficient quantity to be economically transported. Thus provision of some kind of storage facility is essential.

2.2.4 Smaller Waste Stream

Recycling avoids wastes going into the waste stream and thus saves expenditure in the treatment and disposal of that waste (NSW Recycling Committee 1988; Commonwealth of Australia, 1986). Since waste is moving away from the waste stream into the processing stream for recycling purposes, the total amount going into the waste stream is reduced and as a result savings are made in the handling of a smaller waste stream. The potential by-product of recycling is a smaller waste stream whose constituent parts are more easily managed (National Commission on Supplies and Shortages, 1976).
<table>
<thead>
<tr>
<th>Area</th>
<th>Outlay for collection of recyclables ($'000)</th>
<th>Disposal and transport cost per tonne (1)</th>
<th>Savings from costs avoided ($'000)</th>
<th>Net Savings (3) ($'000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSW</td>
<td>1100</td>
<td>34.9</td>
<td>1893</td>
<td>793</td>
</tr>
<tr>
<td>Victoria</td>
<td>2919</td>
<td>35.26</td>
<td>1132</td>
<td>-1887</td>
</tr>
<tr>
<td>Queensland</td>
<td>52</td>
<td>19.85</td>
<td>930</td>
<td>876</td>
</tr>
<tr>
<td>WA</td>
<td>344</td>
<td>22.14</td>
<td>117</td>
<td>-227</td>
</tr>
<tr>
<td>Tasmania</td>
<td>0</td>
<td>21.91</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>ACT</td>
<td>196</td>
<td>12.57</td>
<td>264</td>
<td>68</td>
</tr>
<tr>
<td>Northern Territory</td>
<td>0</td>
<td>14.01</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Australia</td>
<td>4913</td>
<td>11.89</td>
<td>4506</td>
<td>-407</td>
</tr>
</tbody>
</table>

1 Equal to expenditure of waste transfer and waste disposal divided by the number of tonnes of waste disposed of.

2 Equal to transfer and disposal costs per tonne multiplied by the quantity of waste recycled.

3 Equal to avoided costs less outlay for collection of recyclables.


Table 2.2: Australia: savings from recycling, 1989.

However, it must not be overlooked that recycling requires expenditure in the outlay of the facility. Sometimes the outlay is very expensive such as in Victoria. Though no information has been collected about Victoria's recycling because it was considered out of scope of this thesis, it is possible that the service is either highly technical and involves huge expenditures on mechanised systems or perhaps it is labour intensive and labour may be very expensive in the region. It indicates that high outlay
expenses can offset any financial savings resultant from a reduction in the size of the waste stream. However, other changes such as a smaller, more manageable waste stream, are a strong benefit for adopting recycling.

2.2.5 Risk

Because of its size of operation, a resource recovery facility calls for a very substantial investment and such projects are not free from risk. The technology at present is highly complex and generally unproven. There are numerous combinations - all of which promise, but cannot assure that the proposed facility will be financially self sufficient (Burkes and Clint, 1977). This lack of experience is a hindrance to recycling as it does not appear attractive to prospective investors (Kharbanda and Stallworthy, 1990).

Trouble centres on the risk inherent in a developing technology and an enterprise that depends on supply and demand for its success. The market related risks are the ones that the municipal governments don't assume willingly or easily, even if the potential benefits are great. On the other hand, most city officials understand political risks, and the political risk of failure is great.

Furthermore, the resale value of such facilities fluctuates greatly. This is a major disincentive to both local authorities and voluntary organisations (Wilcox, 1976).
2.2.6 Market

2.2.6.1 Demand

"What is recovered must be sold". Clearly this is an axiom of resource recovery (Abert, 1979). There is little to be gained from building a resource recovery facility if the recovered materials cannot be sold. (Adams, 1979). In fact markets are such an important consideration that the recommendation of the National Association of Recycling Industries of USA. is "markets first; collections second" (Abert, 1979). As part of the success of any effective program, demand for products must be made by the general public (Ashworth, 1992). In this case demand can be made either through new markets or market replacement where people prefer recycled products to virgin material.

Market development is the neglected segment of the recycling loop. Around the world far too much emphasis has been placed on the "feel good" and "simple" segments of source separation and collection of recyclables (Frodsham, 1994). The importance of developed markets has been realised time and again when there have been gluts of collected materials. For example, there was so much waste newspaper collected in California in the late 1980's that the States either had to dump or put recyclables in long-term storage (Hepler, 1994). Ashworth goes on to say that without a market, the whole process and the raison d'etre for the process is questionable (Ashworth, 1992).

2.2.6.2 Supply

The supply of any commodity would depend upon the price, quantity and quality. Because of the heterogeneity and possibility of high
contaminants in waste material, the quality of recycled goods cannot always be guaranteed and so using recycled materials is a risky proposition in comparison to raw material where the quality is more or less predictable and steady (Cannon and Smith, 1975). With raw materials, the product quality and specifications are also easier to control (Holmes, 1981).

The quantity of products, being dependent on domestic goods discarded by consumers, may vary or change and be a hindrance to the use of such goods in production. A good example of this is experienced by the Wollongong City Council each year. The amount of rubbish going into the tip increases every Summer (in the Southern Hemisphere) as shown in fig. 2.1. This increased amount usually consists of yard clippings, old leaves and dead branches as well as the disposal of "antiques" that have been stored in garages (Clunie and Taylor, 1978). However, during the winter months, the generation of wastes is lower as consumer purchases decrease following Christmas shopping (Clunie and Taylor, 1978). Such seasonal variations have to be considered with a recycling facility as they would affect supply quantities. This unpredictability of maintaining a dependable long-term supply of waste material may defer prospective industries from investing into it (Porter and Roberts, c1985). However, unlike the supply of primary raw material which varies with world markets eg. copper, lead etc and thus tends to be unsteady, recycled material is determined by local conditions and considerably steadier.

More importantly, with supply being dependent on consumer preference and affluence change, its composition is likely to change over the life of a recovery plant (Alter, 1979). This unpredictability of recycled goods has a negative affect on supply and consequently to its usage.
2.2.7 Price of Recycled Material

The price of recycled material determines to a great degree the level of recycling that is practiced. Prices of secondary materials are known to fluctuate widely, with important implications for the structure of the recycling industry and the level of investment in plant and equipment.

In the markets, commodities have their own values which are determined by the supply and demand in the market place (CMIA-BHP, 1991). Recycled goods price too, is determined by the same interactive economic forces that govern all other commodities. Thus the price of recycled material will have to be competitive with other materials in the market, in this case, the price of virgin ores.

In earlier times reliance was usually on virgin material ore because it was cheapest. It also occurs in concentrated form, is of higher quality and less contaminated than recycled material. Gradually as more concentrated ores are extracted, the mining industry turns to lower grade ores. Eventually as the sources become increasingly difficult to extract, a point is reached when the costs of extraction are higher than costs of recycling (Tietenberg, 1992; Alter, 1977). This is because as supply decreases and demand remains constant, prices rise. At this point recycling flourishes for it offers manufacturers materials of reasonable quality at costs lower than or competitive with prices of virgin supplies (Alexander, 1993; Franklin et.al, 1979).

For an efficient price of recycling to be achieved, the social costs of disposal should be considered because the benefits of recycling cannot be calculated on purely economic terms. Tietenberg in 1992, suggested that
when comparing other methods of disposal to recycling, the total costs should be considered ie. social costs rather than economic costs alone, because social costs provide the real price of disposal (Tietenberg, 1992).

Fig 2.1: The efficient level of recycling

When the private marginal cost of disposal (MCp) is lower than the marginal social cost of disposal (MCs), the market level of recycling (where the marginal cost of recycling (MCr) = the marginal private cost of disposal) is efficient. Only if all social costs are included in the marginal cost of disposal will the efficient amount of recycling (Qs) be attained. For waste disposal to be effective, the financial cost of disposal should be lower than the social cost (Tietenberg, 1992).

Most consumers have free use of municipal waste collection systems ie payment is not based on volume (Anderson, 1976). This creates a
divergence between private costs of disposal, which are zero and social costs of waste disposal, most of which are reflected in municipal budgets for waste collection, incineration, landfill, and the like (ibid). Some social costs such as air and water pollution from waste processing activities are not reflected in municipal cost calculations (ibid). An example of the above statement can be seen in littering. The social cost of littering is the aesthetic loss plus the risk of damage to automobile tyres and pedestrians caused by sharp edges of glass and cans lying about (Tietenberg, 1992). The social cost of littering is not included in the cost of disposal even though it is a cost that everyone must pay. This is so, because it is not a monetary cost and cannot be evaluated. If it were to be considered, the social cost would be higher than the cost paid for disposal and recycling would be efficient in the market.

Thus while comparing other methods to recycling, it is essential that all costs be considered rather than economic costs. Then the real benefits of recycling would become apparent and perhaps it would appear more attractive than other methods.

2.2.8 Balance of Trade

A number of macro-economic benefits can be derived from recycling. Global resources of material are distributed unevenly between countries, so that for many countries the recycling issue has received great attention as a means of reducing dependence on foreign supply.

The re-use of products already in the production stream provides a domestic source of materials. This reduces the need for a country to import costly raw materials from other countries. Consequently it can also be an
incentive to export eg. in Sweden, an important factor in the program to encourage waste paper recycling has been the need to avoid a shortfall in the raw material for paper products, since this is one of the country's most important exports (Bidwell, 1976; Donato and Ferrero, 1980). In fact some of the largest impetus to exporting recyclables comes from the monetary benefits that result from exporting such commodities. Some of the largest companies in Australia trade in recycled goods eg APM. The country exported 47328 tonnes of waste paper in 1988-89, mostly to Indonesia, India, Philippines and Taiwan (pers. comm APM, 1995)

While recycling is generally considered beneficial to the balance of trade position for countries, it must not be overlooked that recycling may lead to a negative effect for a nation that exports raw material. As other countries start recycling, the demand for virgin raw material is reduced and the supplying country might experience losses eg. if all countries started recycling paper, the demand of virgin material would be reduced. This could prove to be unfavourable for countries like Sweden which export paper.

2.2.9 International Relations

Due to strict environmental regulations and the lack of disposal sites, many of the developed countries have difficulties getting rid of their waste. In order to resolve the situation, nations exploit the economic situation of poorer countries.

The political rectitude of such shipment comes to the forefront in later years. It is then realised that the rich nations have taken advantage of the poorer ones and this embitters relations between the two countries. We
see waste as being everyone's problem, so cleaning it up should involve everyone. Exporting it overseas simply makes it the problem of someone else (Selinger quoted in Cook, 1992). Recycling uses this waste, preventing its shipment and thus helps improve relations between nations.

2.2.10 Income or Expenditure for Industry

2.2.10.i New Industrial Products

The reclamation of material from waste results in the industry having more material to make products from eg. in Europe and USA, crushed glass (glassphalt) is used to make roads (Skidmore, 1990). Whether it be through the introduction of more raw material of the same quality into the manufacturing process, like aluminium, or through the introduction of new products eg glassphalt, it adds to the overall products in industry. This provides greater scope for expansion of industrial products.

Industries can make recycling easier by redesigning their products for ease of recycling by eliminating mixed material and reducing the use of toxic substances. In short adopting "clean technology" (King, 1980). Changing product specifications can often result in increasing secondary material usage and provide an impetus to recycling (Bower, 1976).

2.2.10.ii New Businesses

The introduction of recycling in the market can lead to the start of new businesses. For example, in 1992 in USA an alliance of 25 companies for buying recycled products and materials was introduced. Within the year, the organisation grew by 490 companies, mostly small businesses (Hepler, 1994).
2.3 SOCIO-POLITICAL

2.3.1 Image Enhancing

2.3.1.i Industries

Environmentalism is on the rise as a marketing strategy for many businesses.

*By adopting recycling, the company can enhance its image in the eyes of the public and beat its rivals in the competitive market for the environmentally-conscious public would favour a company which is environmentally-friendly.* (Erwin and Healy, 1990).

This desire for a "green" image is increasingly being viewed as important for the public relations of the companies and presumably to their profits. (Pausacker, 1975; Oskamp et. al, 1994). Large companies vie with each other to flaunt their green credentials (Fairlie, 1992).

*In business, the environmentally conscious company is going to do well...the business community can be expected to adapt to the emerging new situation or lose money* (McLaughlin, 1990).

Public relations put forth by manufacturer's campaigns promoting recycling for improving their public relations is an incentive for recycling. (Hubick, 1991). K-Mart in Australia ran a K-Green program in which customers who declined plastic bags were given a 2 cent token to deposit into boxes at checkouts. By the beginning of October 1990, the program had
saved 1.6 million plastic bags and raised $40,000 for green projects in the community (Hubick, 1991). Such an effort would result in a positive effect on the community's outlook of the company.

Though industry is offering support in principle for recycling, and with a couple of notable exceptions, industry's practical efforts in this direction have been spasmodic and limited, largely because the market prices of primary resources usually reflect only the costs producers face. They do not reflect the costs borne by the wider community, or the costs to future generations of a depleted natural resource base. Industry thus tends to favour primary resources over secondary (recycled) ones.

2.3.1.ii Government

The government gains its votes by supporting environmentally-friendly activities. Like any political body, the image of the local government is a vital aspect of its existence. Governments will have to get involved in recycling if the public demands it. Often the government involves itself in such activities only when it appears as politically attractive and as a means of winning public support (White, 1983).

2.3.1.iii Society

Support from the society is essential for the success of any program. Recycling is welcomed by society which makes it easier for the government to go ahead with the provision of facilities (Erwin and Healy, 1990). Society's support is vital. Active resistance is expected to be encountered if it is missing (The Environment Council, 1992).
2.3.2 Individual's Participation

Success in the recycling of domestic wastes does to a great extent depend on the participation of individual households (Liptak, 1991). Individuals can make their contributions to protecting the environment either passively or actively (Ryding, 1992). The passive way is to re-orient their choice of purchases in favour of environmentally friendly products. Another important passive contribution to recycling is by way of separating household waste. (ibid). The active way to assist in environmental protection work is through participation in environmental organisations, so called "green parties" and in many forms of citizens environmental advisory boards (ibid). Direct public participation in the planning and decision making process often makes people more amendable to apparent sacrifices and associated excess costs of environmental management (ibid).

Studies of recycling and other environmentally related behaviours suggest a large variety of reasons why people may choose to participate in recycling programs. Some people participate in resource conservation activities because of basic underlying values towards the consumption and use of things (Simmons and Widmar, 1990; Barton, 1979). Some grew up in families that saved and reused materials because it was the right thing to do. Others might be motivated by the desire to live as simply as possible, or by a sense of responsibility toward the future, future generations, or the environment itself (De Young 1984, Arbuthnot 1977, Heberlein and Black 1976, Webster, 1975 in Simmons and Widmar, 1990).

People also tend to recycle because it is "trendy", "topical" or a socially desirable activity (Simmons and Widmar, 1990). This attitude is a result of
the social awareness atmosphere created by environmentalists who have pushed recycling vehemently for the last twenty years. It is also a chance for the individual to feel good about being environmentally-conscious. People who participate in recycling neither gain nor seek benefit (Thomas, 1987). They derive satisfaction from the knowledge that their good deed is helping community groups, resources and the environment (ibid).

A potential barrier to recycling is a sense of lack of personal salience ie. people's belief that they alone out of billions can't really make a difference; that their individual actions do not matter. Hence though they hold positive environmental attitudes, do not recycle (Arbuthnot 1977; Hungerford and Peyton, 1981; Champeau and Peyton, 1983 quoted in Simmons and Widmar, 1990).

Another barrier to recycling is people's belief in technology. People believe that society will never reach a stage of desperation because scientists will certainly come up with a solution before it is too late. This attitude of "technical optimists", as Pausacker defines the western society, who believe technology will solve all the problems, tends to inhibit participation (Pausacker, 1975).

This technological backing is not justifiable in the case of recycling because of the relative lateness of the concern about conservation and consequent lateness in recovering discarded resources. This has resulted in a late start to the research in the field and so far technology isn't advanced enough to separate the wastes (Diaz et al, 1982; Pavoni et al, 1975). Since technology is not available, it is up to the individuals to realise this and take action before it is too late.
It is realised that for recycling to be successful, society as a whole will have to change its buying habits, separate its household wastes and generally become more aware of the overall environmental impact of its lifestyle. The issue is not just one of encouraging people to have a pro-recycling attitude, but to motivate them to initiate and more importantly maintain recycling behaviour (Hajek, 1981).

2.3.3 Source Separation

Source separation could eliminate or at least minimise sorting problems (Diaz et al., 1982). Separating waste at the household level is the most effective way of recycling domestic refuse (Liptak, 1991; Pavoni et al, 1975). Amongst the most successful nation that have high recycling rates, Japan ranks first for having achieved 50% recycling targets (Corson, 1990). Their highly sophisticated program is dependent upon the cooperation of the community. With few expectations residents in Japan’s communities separate their trash into six different classifications to simplify recycling (Corson, 1990)
As a conscientious householder you would get no reward for minimising waste and recycling. If you composted and recycled all your waste you would still pay exactly the same as the person across the road who could not be bothered recycling and stuffed the 240 litre garbage bin full every week. Can you imagine running an energy or water conservation underlined by the message that regardless of consumption you will all be charged the same anyway? The concept is ludicrous yet this is just the handicap that the campaign to halve waste to landfill is labouring under (Frodsham, 1994).

There are normally few monetary benefits to be gained from separating at source. Though people may recycle for other social or environmental reasons, the absence of any monetary return from the activity is expected to impede its enthusiasm

2.3.4 Technology

The state of development ie. the level of technological advancement greatly affects recycling (Abert, 1979), "the amount recovered depends upon the socio-economic development of the country concerned" (Diega, 1981 quoted in Smil, 1984). Advanced nations with the technical skill and equipment would be better equipped to recycle than other nations (Kinzelbach, 1981 quoted in Smil, 1984). However the lifestyles of poorer nations seem to favour the recycling of products, for out of necessity, all products are reused and then passed down the social ladder until they are rendered completely useless.
Recycling in poorer nations is not necessarily beneficial for the environment, nor is it practiced with the purpose of preserving nature. Example in China, coal ash, which is recycled and used for construction purposes even in the richest nations, is dumped, even though it is easily recoverable. This is done simply because there is no necessity for the material (Smil, 1984).

While some of the problems associated with separating waste can to some extent be overcome by technological advancement through provisions of recycling facilities by the municipalities, labelled products from manufacturers (the new concept of eco-labelling seems much in vogue), or remodelled kitchens (Liptak, 1991; King, 1980), little technology exists for waste separation (Hagerty et al., 1973).

Magnetic separation exists and is used for steel, air blowing is common. It separates wastes by weight. Size separation is also existent but not very commonly used because of the mixed size of domestic wastes.

However there are several technical problems associated with recycling:

1) The technology may not exist at all eg. no process exists for recycling "thermostat" plastics such as Melamine cups and saucers, or Formica table top laminates (Spoerli, 1994).

2) The technology may exist but could be too expensive or elaborate to use. Often the problem is one of scale. Designers and manufacturers of equipment are presently unable to offer firm guarantees of either performance or operating costs. There is no proven technology in
operation. (Alter, c1983). Because the technology has not been used before, there can be several mishaps and the risk associated with a new technology cannot be ignored. In almost all countries of former western Europe plants for automatic waste separation that have been built have generally been a failure (Spoerli, 1994).

3) The technology may be in existence and useable, but there could be social or other objections for eg. plastic bags can be recycled to make plastic toys etc but this process leads to environmental pollution and thus is often unacceptable.

4) The technology may be known about, but may require too much skill or knowledge for those involved; eg. the sorting of different plastics is seldom done because of the difficulty of training sorters to do it accurately (Vogler, 1981).

Though there is not much technology presently available for recycling, it is expected to increase in the future, as interest is expanding. It is clear however, that as technology advances, newer products will be introduced and methods to recycle efficiently will appear. These would provide encouragement to recycling and recycling levels would increase (Menke-Glucert, 1980).

2.3.5 Awareness and Publicity

Awareness about recycling is growing as society is becoming increasingly aware about environmental issues. The experience of various countries that have used recycling as a method of dealing with waste have
shown that it can only work if a considerable effort is made to educate and promote awareness amongst the population (UNESCO, 1994).

The NSW Government conducted a survey in Sydney which concluded that there was a close relation between residents' awareness of what can be recycled and actual recycling rates. This implied that public education could be an effective means of increasing participation rates and yields (NSWEPA, 1994).

<table>
<thead>
<tr>
<th>Material</th>
<th>Residents knowledge of what could be recycled</th>
<th>Recyclable materials recycling rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newspaper</td>
<td>86%</td>
<td>73%</td>
</tr>
<tr>
<td>Glass</td>
<td>78%</td>
<td>73%</td>
</tr>
<tr>
<td>Pet</td>
<td>63%</td>
<td>52%</td>
</tr>
<tr>
<td>Aluminium</td>
<td>50%</td>
<td>40%</td>
</tr>
</tbody>
</table>


Table 2.3: Comparison of awareness of recycling to recycling rates.

Like anything else which is new, recycling also needs to be publicised to gain support (The Environment Council, 1992). Generalised messages promoting recycling - as those in mass media, are less likely to be effective than messages presented at the point of action and at the appropriate time of action. However, they increase awareness and contribute to making people more receptive to direct messages. (NSW, EPA, 1994). People are more likely to participate more frequently if they have been contacted personally in relation to the service.
Recycling and resources is now attracting attention from all those concerned with waste management and the literature on the subject is growing fast. It is now figuring as a curriculum subject at schools and universities (Holmes, 1981). Conferences and seminars are being held at regular intervals and the papers presented are published later, and so made available to a wider audience (Kharbanda and Stallworthy, 1990).

Some of the impetus in the marketplace is coming from a change in the attitudes of consumers and it is expected that a growing awareness in the field will lead to greater pressure by the individuals on governments and industries and further enhance recycling. As an entire community learns to recycle this has flow-on effects. Those participating make a difference by conserving valuable resources and changing the attitudes of others by example.

### 2.3.6 Government

The task of governments is to attend to the needs of the people and the welfare of the environment. Market forces alone cannot fully promote waste recycling, even if recycling is regarded as desirable, so government intervention is often necessary (Potier, 1977; Dougherty quoted in Hepler, 1994).

Legislative incentives and disincentives greatly affect recycling (Kharbanda and Stallworthy, 1990). More exacting regulations to be complied with make it more difficult to dispose of wastes as freely as before so recycling is considered (Kharbanda and Stallworthy, 1990). Except for very small, closely knit communities, legislation is much more effective than
depending on voluntary efforts (Corson, 1990). An example of this was seen in San Francisco where residents were financially motivated to separate their garbage. The result saw that co-operation for the program increased by 50% when separation decreased the monthly garbage collection bill (Liptak, 1991).

In another example, tax incentives encouraging companies to recycle were seen as most valuable encouragement to recycling in USA (Hepler, 1994). After a glut of waste paper collected in the late 1980's, the USA Government passed the Recycling Content Laws (RCL) requiring newspaper publishers to use a specific amount of recycled content in their newspapers. These laws had a great affect and it created the market that was needed (ibid).

Thus, it is concluded that legislation could be very effective in increasing recycling participation.

2.3.7 Employment

Collection centres and processing plants need workers to help run their operations. Businesses need employees to market and sell products made from recycled materials. And manufacturers need engineers, chemists, and technicians to design and run new processes for extracting and using recycled materials. (Bigham quoted in Frodsham, 1994).

Recycling may lead to either a decrease or increase in job opportunities at industries, depending whether the shift in production patterns to accommodate recycling were more labour intensive or more mechanised than the previous production process. For some products, there
is sufficient technology like for steel separation which can very easily be
done with the help of a large magnet. However, for many others like
plastics and glass, the best solution to sorting is by hand. Manual labour
leads to increase in employment and this can be seen as a further benefit of
adopting the idea.

At the same time, introducing recycled goods in production may
reduce jobs through a change in production pattern, as industries become
increasingly sophisticated and perhaps more mechanised to accommodate
recycled materials. In most cases, recycling only alters the employment
pattern and being labour intensive, provides more employment (Abert,
1979). According to the Environmental Defence Fund study, recycling
creates 36 jobs per 10000 tons of municipal solid waste against 6 for
landfilling and 1 for incineration (Liptak, 1991). This figure may be true only
to the country under consideration but at the same time it is an indication
to the increases that can result in labour as a result of adopting recycling.

Manpower is not usually in short supply in Third World countries
but labour with the necessary skills and abilities may be. Although the
collecting and processing of waste offers the chance of work to unskilled and
handicapped people, there is a need for skill in the following areas:

- operation and maintenance of machinery
- carrying out tests to distinguish between different materials
- Talking to customers and suppliers of materials
- Certain chemical and engineering jobs, especially those that involve
poisonous, acid or caustic materials, and dangerous operations (Hubick,
2.3.8 Health

Waste is usually dirty, often smells unpleasant and may contain insects, vermin or other unpleasant impurities (Vogler, 1981). People working in such conditions tend to be susceptible to diseases because of the unhygienic nature of the job.

A benefit of recycling is that it reduces the toxicity and quantity of waste streams (WMANSW, c1990). Reduced waste amounts results in less number working in the management of wastes and thus less people working in dirty, unsafe environments. (Adams et al. 1979)
The solid waste recovery systems benefits to health include - elimination of blowing dust, dirt and paper; elimination of odours; control of rodents; prevention of ground water leachate; prevention of methane gas generation (Adams et al. 1979).

Recycling is more acceptable than tips because it attracts cleaner, sorted wastes and none of the putrescible wastes that attract vermin (Bower, 1976).

2.4 ENVIRONMENTAL

2.4.1 Raw Material

Conservation of scarce natural resources is perhaps the most important of all benefits of recycling (Holum, 1977; Commonwealth of Australia, 1986). As the economic process extracts resources from the environment and generates wastes, recycling comes in at both stages - reducing the amount of resources extracted from the environment and reducing the amount of wastes generated. This dual benefit achieved through recycling is clearly explained by the models put forth by Santos in 1990

Santos considers humans and the environment as an interacting unit called the "anthroposystem". The anthroposystem is divided into:

a) matrix-consisting of non-living and non-productive parts of the system like buildings, streets, air and water
b) producers-those that manufacture or yield products including agricultural and industrial
c) consumers- humans and domesticated animals

d) decomposers-resource recovery plants, waste-water treatment plants, spray collectors etc

Figure 2.2 - The Anthroposystem as propounded by Santos.

By recycling wastes, the amount that goes into the environment as pollution is reduced for it goes back into the production-process as resources (Santos, 1990; Pearce and Walter, 1977). This also helps by adding material to the production process which does not come from the environment but from the decomposer. Recycling post-consumer waste can decrease the demand on virgin ore (Erwin and Healy, 1990; Hajek, 1981). Once such material is discarded and buried it becomes too difficult to recover economically (National Commission on Supplies and Shortages, 1976; Carpentier, 1980).
2.4.2 Recycling in Comparison to Other Waste Disposal Methods

Society's expectations related to environmental protection continue to rise. Methods used even a decade ago for disposing of waste are unacceptable today (Erwin and Haley, 1990). This gives further impetus to recycling as a means of getting rid of waste since it is accepted to be more environmentally-friendly than other methods of waste disposal.

Historically when land was plentiful and the waste stream less hazardous, the remnants could be buried in landfills. But as land became scarce, burial became increasingly expensive and landfill started being viewed as a nuisance for the smells, vermin, dust, resulting ground-water contamination, leachate and chemicals that were released from the dump affecting the people living nearby and working there. (Kharbanda and Stallworthy, 1990; Kinney, 1979). Sanitary landfill can eliminate some problems like leachate. But in such landfills, degradation can be very slow due to the lack of aerobic degradation microbes which cannot function in a low-oxygen environment (Erwin and Healy, 1990; Rathje and Murphy, 1992). This means that new landfill sites must be developed frequently due to this low degradation (Erwin and Healy, 1990). Recycling increases the life of a tip site by reducing the amount of waste going into it.

Everyone objected to living near a landfill and the famous phase NIMBY- Not in My Backyard came to the forefront (Erwin and Healey, 1990). New disposal facilities are politically difficult to open. For example the proposal for a domestic garbage landfill at Londonderry on the outskirts of Sydney met with resistance from residents (Industry Commission, 1991).
Gradually even though landfill may well be the quickest and the cheapest way of getting rid of waste at present it is increasingly being recognised as an unsound solution to the problem. It is regarded as a simple postponing of the problem by taking the waste out of sight and leaving it for some future generation to deal with (Kharbanda and Stallworthy, 1990).

Other waste disposal methods like incineration are not generally favoured because they require high capital investment, technical know-how and are expensive to operate (Conn, 1977). (refer Table 2.1). These methods are more common in many parts of the world because of their simplicity compared with recycling. However, there is increasing public opposition towards them for they do not really conserve resources in the complete sense. eg transformation of paper into energy (through incineration) though superior to throwing it away (as in landfill), is not as desirable as converting paper into paper (as recycling) (Erwin and Healy, 1990; Kinney, 1979; Connett and Connett, 1994).

2.4.3 Energy

Recycling is defined as the utilisation of waste material with the aim of recovering energy and secondary raw material (Abert, 1979; Keeler and Renkow, 1993). While we have discussed the latter part of the definition above, we still need to look into the first part of the definition-"recovering energy". Energy savings result from waste recycling when the energy used in collecting, separating and processing the recyclables is less than the energy used in originating and processing primary material and disposal of waste (Porter and Roberts, c1985; Dent, 1990). Using less energy also implies reduced pollution (Goldsmith and Hildyard, 1988).
Table 2.4: Environmental benefit derived from substituting secondary materials for virgin resources.

Though there is a significantly large range of energy savings that can be achieved through using recycled materials, the fact remains that processing recycled materials uses less energy in comparison to the use of virgin materials.

The significant increase in energy prices throughout the world since 1973, also has important implications for recycling. This is particularly true of energy-intensive activities such as production of aluminium and paper (Bower, 1976). With rapidly decreasing quantities of fossil fuels, prices of energy will go up and favour recycling. This will occur because of the lesser usage of energy in processing recycled goods in comparison to virgin ore.

2.4.4 Ecology

Recycling reduces the ill-effects of primary production like air and water pollution, disruption of the scenic natural environment and deprivation of recreational facilities (Gandy, 1992; Haun, c1991: Anderson,
1977). Consider the example of paper recycling. Much paper comes from natural forests or large plantations.

*The cutting of trees means depleting the nutrients in the soil. It also often means causing erosion problems, harming the natural ecological balance of an area, and producing 'eyesores''*(Pausacker, 1975).

Plantations where the trees are grown do not look attractive to many because only one type of tree is planted. The plantations also take up land that could be used for farming. By recycling, the amount of trees requiring planting will be reduced and the associated disadvantages of having plantations will also decrease (Bailey, 1991; Brown et al, 1992).

Recycling of steel and aluminium for example reduces the need for mining iron and tin (Joy, 1990). Reduction in mining lowers landslides and reduces disturbances of the local flora and fauna.

2.4.5 Pollution

2.4.5.i Contamination

A major factor in the drive towards materials recycling has been the strong popular demand that these materials should not contaminate the soil, water and air (Sachdev et al, 1982). Global environmental aims feature widely within the rationale for promoting recycling at local, national, and international levels (Gandy, 1993). It is of interest that most of these potential environmental benefits relate to global or regional problems such as the reduction of greenhouse gas emissions from the production process and landfill sites, yet the location and preparation of recycling facilities also have a local environmental impact, suggesting that the comprehensive
recycling programs may involve a trade-off between local and environmental objectives (ibid).

<table>
<thead>
<tr>
<th>ENVIRONMENTAL BENEFIT</th>
<th>ALUMINIUM</th>
<th>STEEL</th>
<th>PAPER</th>
<th>GLASS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Pollution</td>
<td>95</td>
<td>85</td>
<td>74</td>
<td>20</td>
</tr>
<tr>
<td>Water Pollution</td>
<td>97</td>
<td>76</td>
<td>35</td>
<td>-</td>
</tr>
<tr>
<td>Water Use</td>
<td>-</td>
<td>40</td>
<td>58</td>
<td>50</td>
</tr>
</tbody>
</table>

(Source: Kharbanda and Stallworthy, 1990; UNESCO, 1994)

Table 2.5: Environmental benefits derived from substituting secondary materials for virgin materials.

The above table provides significant data to assess the method's environmental suitability. With reduced air and water pollution and water use, processing recycled material is obviously an environmentally favourable option than processing virgin material. However, it should not be overlooked that recycling processes have their own environmental impacts. Environmental pollution may result from the recycling process and such factors have to be taken into consideration while evaluating the real costs of recycling (Dunz, 1979).

2.4.5.ii Noise

A refuse disposal plant will produce noises from numerous sources within the plant and will be responsible for some external noise too (Serper, 1978). Noise levels at the boundary of the site depend upon many factors including the back noise level, the degree of isolation of individual
components of the plant, the degree to which the whole plant is enclosed, and the type of construction of the buildings. If the facility is located where refuse delivery vehicles pass through residential areas or other sensitive areas of the community, it may cause discomfort to the public (ibid).

2.4.5 iii Traffic

If house to house collection of recyclables are to be carried out, some kind of transport is required. Often these are trucks and they cause inconvenience to residents by creating of noise and also increase the amount of traffic and thus pollution released into the atmosphere.

2.4.5 iv Air

Besides the air pollution that might result from the trucks collecting recyclable materials; odours and gases released into the atmosphere by the recycling of materials like plastic is often harmful for the environment.

2.4.6 v Litter

Recycling may reduce the amount of litter (Klee and Gordan 1979). Though the above is often stated, there is no proof that recycling does prevent litter (McHarry, 1993). There is more space in the garbage bin once the recyclable goods are removed and thus there are less chances of overfilling and consequently of spillage thus reducing litter. But at the same time, for collection of recyclables, residents have to place their goods outside. This can result in litter if the container is not suitable. It is however believed that litter will reduce as recycling gets more effective and people realise the value of materials.
2.5 CONCLUSION

This chapter in mainly a review of ideas of previous researchers. They are not necessarily theories and therefore not common to all recycling services. They are however, a result of either some facts collected from various recycling programs, or deductions and inferences made theoretically. Hence, they are guidelines for the evaluation of recycling and provide the basis for evaluating the method.

While attempting to bring all previous aspects or recycling together, rather than considering them in isolation from each other. Segregating one factor from the other was often extremely difficult eg. raw material can be as much of an economic gain as an environmental one. While it can be argued that examining the point economically would be sufficient because of its close relation to others, it is not always so. With savings in raw material there are environmental savings as in the reduction in mining and pollution. Several other factors eg contamination, health, legislation etc also cannot be considered economically. Thus it is realised that all factors are significant and need to be taken into consideration. This indicated the importance of a broad framework for the evaluation of the method.

It was realised that though plant establishment and maintenance costs were important economic factors, demand and supply determining the price of recycled materials and its standing in comparison to other waste disposal methods were of greater economic significance. Transportation costs also seem to be important factors in determining the choice of recycling. Balance of trade and international relations did not appear to be very important or predictable factors. Perhaps this is because recycling is a localised activity.
Being largely local in its effect, community participation seemed to play a very important role in the success of recycling. Social reasons such as image of the involved parties determined to a great extent whether people would participate. Being it is an activity that needs public support to be successful, source separation and factors connected to source separation like education and publicity all came up to the forefront. Even government intervention was seen as a key factor when considering recycling because of its effect upon participation. Employment and health factors along with skill and technology were also considered.

Environmental factors such as savings in resource and energy as well as the comparison of recycling to other methods of waste disposal were considered because of the impact of recycling upon them. If it weren't for these factors, recycling would perhaps not have been considered by many.
Chapter 3: HISTORY OF RECYCLING

3.1. INTRODUCTION

This chapter briefly traces the history of recycling through Australia and the State of NSW in order to understand the changing status of recycling over the years, and to establish where it stands today. This provides an essential background to recycling in Wollongong which is the area of the case study. The history of recycling in Wollongong is traced in detail. The present service is also discussed to provide some background for the evaluation of this service which is done in the following chapter.

3.2. RECYCLING IN AUSTRALIA

At the 1974 Australian Waste Management and Pollution Control Conference, it was noted that Australia was in the 'early stages' of development of processes to deal with solid wastes (Varajavandi and Fischof, 1974 quoted in Hubick, 1991). Recently however, in Australia, as in other countries, a change in attitudes to awareness in the management of wastes is occurring rapidly and recycling is being considered as one of the options to be promoted in the future. Concern for the broad issues of waste management was reflected nationally in 1983 by references in the National Conservation strategy for Australia (NCSA) and by the formation of a Waste and Resources Advisory Committee (WRAC) by the Australian Environment Council (WMANSW, 1990)

It was realised that in 1989, 12.3 million tonnes of the total amounts of waste were disposed of by landfill, 379000 tonnes by recycling an 143000
tonnes by incineration. (Industry Commission, 1991). Thus it was realised that landfill was the chief method of disposal. Recycling contributed to only 3% of the total waste that was disposed.


Figure 3.1: Method of waste disposal by councils (1989).

In July 1991, the Australia and New Zealand Environment and Conservation Council (ANZECC) endorsed the development of a National Recycling Strategy for domestic waste and established a National Taskforce to proceed with the development and implementation of the strategy. The main objective of the task force was to develop a strategy for the recovery of post-consumer, domestic waste for recycling. (ANZECC, 1992). In 1992, the Australia and New Zealand Environment and Conservation Council considered the recommendations on establishment of a National Kerbside Recycling Strategy (ANZECC, 1992). The strategy of waste reduction involving a target of 50% reduction in waste quantities per capita by the year 2000, was endorsed by the ANZECC in February 1992 (Waste Recycling &
Processing Service of NSW, 1992) and adopted by the Government as the National Waste Minimisation and Recycling Strategy.

The new strategy encourages all States and Territories to remove regulatory impediments to the use of recovered materials and promote the development of new products from and markets for recovered materials. It is realised that in most regions recycling is not a very important means of getting rid of waste. The following table supplements this statement.

<table>
<thead>
<tr>
<th>REGION</th>
<th>LANDFILL</th>
<th>INCINERATION</th>
<th>RECYCLING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sydney</td>
<td>93</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Inner NSW</td>
<td>98</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Outer NSW</td>
<td>98</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Melbourne</td>
<td>95</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Inner Victoria</td>
<td>97</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Outer Victoria</td>
<td>96</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Brisbane</td>
<td>95</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Other Queensland</td>
<td>98</td>
<td>&lt;1</td>
<td>2</td>
</tr>
<tr>
<td>Perth</td>
<td>98</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Other WA</td>
<td>99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adelaide</td>
<td>100</td>
<td>&lt;1</td>
<td></td>
</tr>
<tr>
<td>Other SA</td>
<td>100</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Hobart</td>
<td>99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Tasmania</td>
<td>100</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>ACT</td>
<td>94</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Northern Territory</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Australia</td>
<td>96</td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

Percentages may not total 100 due to rounding.


Table 3.1: Methods of waste disposal by councils (1989).

Though recycling contributes to a very small proportion of the total waste handling, it is present in almost every region except Hobart, Northern territory and Other WA. It is increasingly being considered above other methods like incineration which is present only in 5 out of the 16 regions.
There is obviously great scope for expansion of recycling in the future. The following table gives a better indication of potential recyclable amounts in the country.

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>TARGETED RECYCLING RATE FOR 1995 (1)</th>
<th>RATES ACHIEVED BY FEBRUARY 1991 (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastic Containers</td>
<td>25%</td>
<td>&lt; 1%</td>
</tr>
<tr>
<td>Glass Containers</td>
<td>45%</td>
<td>24%</td>
</tr>
<tr>
<td>Aluminium Cans</td>
<td>65%</td>
<td>52%</td>
</tr>
<tr>
<td>Steel Cans</td>
<td>25% *</td>
<td>26%</td>
</tr>
<tr>
<td>Liquidpaperboard</td>
<td>20%</td>
<td>na.</td>
</tr>
<tr>
<td>Newsprint</td>
<td>40%</td>
<td>16%</td>
</tr>
<tr>
<td>Paper packaging industry</td>
<td>71%</td>
<td>na.</td>
</tr>
</tbody>
</table>

* For 1996


Table 3.2: Recycling rates and targets achieved.

It was thus realised that given the appropriate incentives, house-to-house collection can prove a highly effective form of recycling (Hajek, 1981). The following table indicates this point further.
It is concluded that though recycling is being pursued in most states it is still not widespread and amounts to only a small proportion of the total waste management. Hence there is scope for future expansion and the results from participating households indicate that such expansion if pursued would be promising.

The Government has established specific goals and set targets for the implementation of recycling in the country. However, in many ways the development of the solid waste industry in Australia is hindered by an uncertain and unstable regulatory environment, including proposals for regulations which will potentially discriminate against the development of better technologies (Serventy, 1988). A plethora of government agencies can have a bearing on recycling decisions. This creates problems in many directions- not the least being undue delays in approving new investments.
This is illustrated by the response of government agencies to ANM's plans to establish a newsprint brightening facility at its paper mill in Albury, as a first step towards recycling wastepaper into newsprint on that site. The proposal requires consultation with about 10 Commonwealth, State and local Government departments and agencies. (Industry Commission, 1991).

It is also hindered by government at all levels, including local, state and federal, which espouse the necessity for waste minimisation and recycling but retain purchasing requirements which often discriminate against products made from secondary materials in favour of products made from virgin materials (o'Gallagher, 1990).

In the area of recycling there have been some instances of attempting to achieve the social goals implicit in recycling through the marketplace, by regulation and restrictions and the imposition of requirements on elements of the chain of manufacturing distribution, selling, collection and recycling (CMIA-BHP, 1991).

The cost of waste collection by municipal authorities in Australia can be artificially low. This inhibits the adoption of new technologies and further development of technologies (O'Gallagher, 1990). The subsidisation of waste collection by the community but not of collection of materials to be recycled hinders the development of recycling schemes.

Recycling is often led by industry initiative in many fields. For example, BHP steel is supporting recycling steel not just by paying for the scrap steel but by transporting, at its own expense the baled steel from MRF's to its steelworks or detinning plant. They are also researching better ways of collecting, processing and re-using steel cans (BHP-CMIA, 1994).
It can be concluded that recycling in Australia is increasingly being considered as the better option when dealing with waste disposal. There are many hindrances along the way, but there has also been encouragement, and guidelines have been formulated for increasing recycling rates in Australia.

3.3 RECYCLING IN NSW

Along the lines of the National Waste Minimisation and Recycling Strategy, the NSW Minister for the Environment in 1992 set out the NSW Government's goal of achieving a 50% waste reduction in the per capita amount of waste (Joint Select Committee upon Waste Management, 1993). This rate was to be achieved by the year 2000, compared with the base year of 1990 (Cook, Broek, 1994)

At present 96% of the waste of NSW is disposed through landfilling (Industry Commission, 1991). The Waste Recycling and Processing Service, formerly known as the Waste Management Authority recognises that the quantities of waste requiring disposal pose a potential environmental problem and that consideration must be given to ways to reduce the amount of material requiring landfill disposal, thus reducing pressures on the disposal system (Sulo, WMANSW, 1991). Its task included the provision of disposal facilities for solid and liquid wastes generated by forty municipal council authorities in the area, as well as waste from industrial and commercial generators. The Authority receives no state government funding and is financially self-supporting through the collection of user charges and fees from its operations (Waste recycling and processing service of NSW, 1992)
An estimated 5 million tonnes of solid waste are produced in NSW each year. The bulk of this (96%) is disposed by landfill (Industry Commission, 1991). With increasing population pressures and subsequent competing land-use demands, sites suitable for landfill in densely settled urban areas are becoming difficult to locate. Landfill is also becoming an unacceptable method of disposal as people are demanding better environmental practices.

Figure 3.2 - Methods of disposal of waste in NSW, 1989.

The NSW Waste Management Authority in 1993 published a guide for industry to reduce its waste. The plan is based on the same four principles as the EPA plan of USA. The NSWWMA has adopted a waste management hierarchy which is intended to be a "sequential integrated mechanism" with waste minimisation the most important mechanism and landfill gas recovery as the last (van Den Broek et al, no date).
Waste minimisation is believed to be far more difficult to establish because it involves a change in product and packaging, which in turn necessitates a change in buying habits of people. Bringing about such a change in attitude is considerably more difficult than getting people to recycle. Introducing a change in packaging is difficult since people are accustomed to packaging and it helps in marketing the product.

It was thus realised that,

*recycling has an important role to play in diverting materials that are currently disposed as waste, thereby reducing pressure on the waste disposal system and saving resources. However, the success of recycling is dependent on the availability of suitable collection systems and markets for the materials recovered, and can only be achieved with the co-operation and support from all sectors within the community. The NSW Recycling*
Committee, with its wide representation, was established to serve this purpose (NSW Recycling Committee, 1988).

While Government regulation or other interventions in the market place, such as deposit regulation, are used elsewhere to increase the recovery of materials, the Committee considered it preferable to first fully explore the potential of voluntary methods of recycling. Other methods like designing for recycling or waste minimisation, though ideal would probably require legislation to be successful. Source separation from the domestic waste stream is the principle recycling method presently in use in NSW and is likely to remain so in the foreseeable future (Sulo, WMANSW, 1991).

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>TOTAL COMPONENT</th>
<th>POTENTIALLY RECOVERABLE TONNES PER YEAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper and Cardboard</td>
<td>357000</td>
<td>230000 (1)</td>
</tr>
<tr>
<td>Glass</td>
<td>157000</td>
<td>140000 (2)</td>
</tr>
<tr>
<td>Ferrous Metals</td>
<td>90000</td>
<td>50000 (3)</td>
</tr>
<tr>
<td>Non- Ferrous Metals</td>
<td>17000</td>
<td>6000 (4)</td>
</tr>
<tr>
<td>Plastics</td>
<td>129000</td>
<td>6000 (5)</td>
</tr>
</tbody>
</table>

(1) Based on 41 kg/person of clean paper suitable for recycling.
(2) Based on 25 kg/person of glass suitable for recycling
(3) Based on 9 kg/person of food cans which may be cleaned
(4) Based on 1 kg/person of Aluminium cans
(5) Based on 1 kg/person of PET bottles


Table 3.4 : Recycling potential of NSW domestic solid waste.
A survey carried out in 1994 by the NSW State Government indicated that the environment would be the leading issue of concern and the top Government priority by 2004. People's changing attitudes towards the environment implies that recycling would come to the forefront and involvement would increase. In the past year, 90% of respondents said they had decided for environmental reasons to re-use or recycle something rather than throw it away (NSW Government, 1994). Waste management and disposal were cited most often, along with water and air quality when people were asked to nominate the most important environmental issues in NSW today (NSW Government, 1994). Respondents wanted State governments environmental priority to address air and water pollution and waste management issues. (NSW Government, 1994).

In 1991, the NSW Government established the Council Recycling Rebate (CRR) Scheme. This Scheme gave Councils an incentive to establish or improve kerbside collection systems. The CRR Scheme ensures that Councils receive a substantial rebate for every tonne of recyclable collected from households (NSWEPA, 1994). Presently, for every tonne that local councils recycle, the government pays a $20 rebate (NSWEPA, 1994).

Though this scheme was to provide an incentive for councils to recycle, a 1991 Industry Commission report established that only 24 percent of Councils were involved in recycling for cost reduction benefits (Industry Commission). For 66% of the Councils, environmental concerns were the driving force behind involvement in recycling. However, 70% of them believed that the most important barriers to their success were that costs associated with recyclables were too high. Costs often emerged as a problem.
largely because there was little or no market for the collected materials (Industry Commission, 1991).

The main materials collected from house-to-house services in NSW are paper and glass. The following table shows the percentage collected.

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>NSW (PERCENTAGES)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass and Pet</td>
<td>55.3</td>
</tr>
<tr>
<td>Paper</td>
<td>48.1</td>
</tr>
</tbody>
</table>


Table 3.5: Households serviced by house-to-house collections.

Thus it was realised that there was great scope for expansion and that many materials were still not being recycled but the Government was taking the initiative and providing incentives to the Councils to increase participation.

3.4. RECYCLING IN WOLLONGONG

3.4.1 History of recycling in Wollongong

Wollongong is a city on the eastern coast of the state of New South Wales in Australia, 80 kms south of Sydney. The City Council covers an area of 700 square kilometres. It caters for a population of approximately 170,000 persons (IRIS, 1989).
Recycling in Wollongong can be traced back 17 years to December 1977, when the Russell Vale Depot was opened as a recycling centre (Wollongong City Council, no date). It functioned successfully as a buy-back centre and the public was encouraged by way of monetary return for articles, to take back aluminium cans, glass bottles and glass products (Bowland and Morris, 1978). The collection centre received separated items from the community. It was believed that an organised service for separating recyclables at this stage would not be feasible because the it would be uneconomical and too difficult. As stated by A. R. Hales (a spokesperson for the Wollongong City Council at a recycling symposium in 1978)

*It is my belief that a voluntary method of pre-sorting recyclable products from waste in the home is the method of materials recovery most likely to be successful in this area at the present time. A highly organised method of pre-sorting of garbage would fail for:*

a. the great Australian apathy, and  

b. the collection costs would become uneconomical.

*Local government involvement is not encouraged. I am not proposing that local government attempt to become entrepreneur in such an intense field of constant change and haggling as they lack the flexibility. It is a field best suited to free enterprise. But it is certainly time for local government to begin to evolve legislation to evoke change in community habits towards wastage and to become aware of their obligations (Wollongong City Council, 1978).*

Community participation was encouraged and source-separation was believed to be the right way of handling the complicated issue of separating recyclables from the waste.
This buy-back centre was the only service available for about a decade, until 1987, when the Council began a fortnightly house-to-house collection service (Wollongong City Council, 1988). This new service was considered as the start of organised large scale, convenient recycling in the area. This was the "Rise and Shine" Free Weekly House to House Recycling Service to Figtree and West Wollongong Area carried out by the Illawarra Recycling and within six months this service was extended to Unanderra, Farmborough Heights and Mt. Keira. In July 1988, the council endorsed the expansion of the "Rise and Shine" program to be undertaken by the Illawarra Recycling to every suburb in the City.

Within 2 years, by the last quarter of 1989, Illawarra Recycling started running into financial difficulties and was facing closure. At this stage, a possible contract cancellation with the Illawarra Recycling was considered and Council provided financial assistance to enable recycling service. This was carried out by Employment Resources Ltd (ER Recycling). It was recognised that the Illawarra Recycling required financial assistance partly because of the significant failure of expected returns from the sale of recyclables.

However, the problem was not solved by Council assistance. The House to House Recycling Service was unsatisfactory at this stage and the Council decided to terminate the "Rise and Shine" scheme. The scheme thus ended on 16 February 1990, after public notification in the media. The collection of recyclables at collection centres for a stipend still continued.

In July 1990, the Council accepted a fortnightly service put forth by Employment Resources Ltd. (ER Recycling) for four years. By 1991, ER
Recycling was going broke and requested Council to pay some more. The Council decided to end the contract with them and fresh tenders were invited for collection and processing of recyclable material throughout the city with the date of the new contract to commence on 1 January 1992. (Wollongong City Council, 1991)

The next contract was signed for 29 months, till June 1994. This was for the convenience of the Council who wanted to hand over both the garbage and recycling contract as one large project to the next contractor.

The 29 month Contract was once again taken by ER Services and till 1994 house-to-house recycling services for domestic waste was carried out by this company. Towards the end of the contract, in mid 1994, the Council was spending approximately $500,000 on recycling. Up until this time, recycling had been present in most parts of Wollongong Council area. It had had several setbacks and even stopped a couple of times, mainly due to financial reasons. It was not a very big venture for the Council and registered approximately 60% participation.

3.4.2 - Reasons for the introduction of the 1994 recycling program.

The expiry of the Contract is assumed to be the main initiator of the new recycling service. There is no direct proof for the above statement. However, because of the timing of the new service, it can be concluded that the end of the old contract probably prompted the speedy consideration of a new facility. If the earlier contract had been longer, then perhaps the provision of a new recycling service would probably have been put off till such time as the old contract would have expired.
One of the main reasons for the establishment of better recycling facilities follows from the government's decision to reduce the amounts going into the tips. (pers. comm. Jones, 1995). Many Wollongong tips are facing closure and space is vanishing fast. The only tip in the area which accepts household wastes is the one at West Dapto - Whytes Gully Tip and it is expected to have a life of approximately 25 years.

In Wollongong the waste disposal problem is exacerbated by its location on a narrow coastal plain, hemmed in on one side by the sea and the other by the 400 mt. high escarpment. The enormity of the waste disposal problem of Wollongong stems from the presence of a large urban centre, a heavy industrial complex and the mining of coal. The problem is compounded by the relatively small area of land suitable for the disposal of waste generated. Land use conflicts are likely to increase in the future. Recycling is the obvious answer for some waste materials while new uses is the answer for others (Liard, 1988).

As is known, the difficulties experienced now in creating a new tip are enormous due to public pressure. Though landfills may be replaced by other methods like incineration or pyrolysis in the future, such an outlook is only speculative and depends on numerous factors like the improvements in technology, environmental and standards met that must accompany such methods for them to become acceptable.

The Council also considered adopting the recycling facility because the community survey indicated that participation was increasing and overall participation would increase if Council supplied households with a separate bin.
3.4.3 Present program

Towards the end of the ER Services contract, tenders for a new recycling service were invited to begin service in July 1994. The tender had certain guidelines including provision of a bin or crate for collection, long term contracts with buyers and share in profits. It was won by Thiess (The Environmental Services) because it offered the cheapest tender (pers. comm. Jones, 1995).

The Contractor was permitted to build a recycling plant on the premises of council owned land; on the condition that at the expiry of the contract term, the plant shall be transferred to the council and be council property. All bins were to be provided by the Contractor and are to be the property of the Contractor till the end of the Contract (2004) after which they shall be the property of the Council. All the recycled goods are the property of the Contractor and to be managed by the Contractor as pleased. The Council has no rights on the products that come into the plant (Wollongong City Council and Thiess, 1994).

The Council will pay $1.7 million annually to the Contractor for the service but will not be responsible for the day to day running of the program. It will remain as the link between the community and the contractor.

The new recycling service which began in July 1994 is similar to the old service in many ways. It collects recyclables from every household every fortnight. However unlike the old service where people had to provide their own container, this service provides a 240 litre wheelie bin which is green in colour with a yellow lid for distinguishing it from the garbage bin.
The bin is specially designed with two different sections: one for paper and cardboard, the other for cans, glass, plastics and liquidpaperboard. The householder is expected to separate recyclables into these two categories. This is for the convenience of the new mechanised, one-man truck which is used to collect the materials. The truck has two separate divisions and the materials are dropped into separate sections in the truck with the aid of a arm which lifts the bin from the kerb. Previously recycled materials were collected manually.

The most significant difference between the two services has been the construction of the Material Recycling Facility with this new service. This is a central facility where all collected material is first brought to for sorting. Details of this service are discussed an evaluated in the next chapter.

3.5 CONCLUSION

Through the brief overview of recycling in Australia and NSW, it was concluded that recycling has so far not been a very important means of getting rid of waste. It accounted for only 3% of all wastes disposed in Australia and 2% in NSW. However, due to a decrease in suitable landfill sites and increasing public pressure, the government was encouraging the method. In NSW, there was great scope for its expansion and where household services had been provided, there was a significantly high participation and recovery rate. House-to-house recycling was thus promoted and concluded to be the best way of increasing recycling.

Recycling in Wollongong has altered from being a single buy-back centre to in 1977, to a well established house-to house recycling service with bins and mechanised systems by 1994. Through the 17 years, Wollongong's
recycling went through several changes. House-to-house recycling first began in 1987. Till 1994, contracts and contractors kept changing but the service often ended up as a failure due to financial reasons. In 1994, the Council contracted the establishment of a more expensive service with the provision of bins, mechanised pick-ups and an MRF. Several reasons initiated this service. Among them, government's strategy to reduce waste to landfill, lack of suitable landfill space in Wollongong, expiry of the old contract and feedback from the community were the most significant. The details and affects of this service are discussed in the next chapter.
Chapter 4: EVALUATION OF WOLLONGONG CITY COUNCIL'S DOMESTIC WASTE RECYCLING PROGRAM.

4.1 INTRODUCTION

This Chapter uses a case study of the Wollongong City Council Recycling Program to evaluate the promises and problems that have been previously discussed in Chapter 2. These factors are studied along the same criteria as the framework ie. under economic, environmental and social factors.

A problem with this evaluation is that with the program being very new (having begun only in July 1994), most of the information has not been documented. Information was obtained mainly from the Council, through personal communication and may be biased. Thus though many aspects of recycling are covered in this particular evaluation, some were not assessed either due to lack of time, or information.

It fulfils an aim of the thesis; to find the reality behind recycling and assess the framework that has been established about it.

4.2 ECONOMICS

4.2.1. Risk

The initial tender was submitted by the Contractor with the hope of making some money. It had an initial margin for profit planned in the project (pers. comm. Jones, 1995). However, after having operated for about
a year, the profit and loss statement compiled shows that the service is not making any profit (pers. comm. Jones, 1995)

This service is undertaken by Thiess in conjunction with an overall garbage system (pers. comm. Bell, 1995). Being only a small part of the whole garbage system at the Depot, the Contractor can bear the losses from this plant because the rest of the garbage system in Wollongong is running successfully. Profit made from the rest of the garbage system at the Depot makes up for the losses incurred through recycling (pers. comm. Bell, 1995). Thus overall, even though the recycling part may be losing money, the total system is not making a loss.

Starting a recycling service in conjunction with the whole garbage system is perhaps the solution to the risk that many companies are not willing to take. In Australia, and in other countries where garbage is handled mainly by private contractors, recycling could be made a mandatory component. This could operate with greater success than an exclusive recycling service because it seems that the losses incurred through recycling are not so large as to offset the total profits that the operators make through the handling of the whole garbage. Recycling as a solitary operation may result in losses and not be financially self-sufficient. Therefore, it would perhaps be worthwhile to consider it in conjunction with the total garbage system rather than as a separate entity.

4.2.2. Capital

One of the largest hindrances to the establishment of a recycling facility is believed to be the high capital costs. In the Wollongong service, even though land was provided free of cost to the Contractor for setting up
the plant, the costs of the equipment has probably been high. These costs were not obtained because the Contractor was not willing to divulge such information. It would be of interest to see later, perhaps in other case studies if the capital costs are really so high as to deter prospective investors.

4.2.3 Maintenance Costs

The total running costs for the facility are estimated to be $2.7 million for the year. The Council by contract is to pay $1.7 million each year for the facility. This is a threefold increase in costs for the Council. It was paying approximately $500,000 for the previous recycling service. The $1.7 have to be raised from elsewhere for the maintenance of the service and thus recycling appears to be more expensive for the Council. It can be concluded that waste management costs have increased for the government with this new recycling service, rather than decreased as promised. The remaining $1 million ($2.7 million less than $1.7 million paid by the Council) is to be raised by the Contractor from the sale of recycled products (Wollongong City Council, 1994).

An independent audit was carried out in July 1995 and it was concluded that the recycling facility had been unable to meet its expected target of $1.1 million. There were thus no profits from the service. However, there is expected to be an increase in income in the future, as markets become more competitive and the economies of scale increase.

Contrary to the belief that recycling may result in a decrease in total garbage handling costs due to a decrease in labour and reductions in waste-handling charges as the amount of waste decreases (refer section 2.2.4), this service did not witness any such benefits when the total amount of garbage
reduced in the first six months of the service. This indicates that such promises may not be justified.

4.2.4 Collection and Transportation

This new service experienced a large increase in transportation costs with the introduction of the specially designed trucks for collecting recyclables which cost approximately $250,000 each. Collection costs also increased as a result of the new 240 litre green and yellow wheelie bins which were supplied to every household for collection of recyclables. Though the bins have resulted in an increase in the amount of recyclable collected, it has been proven through a survey in Sydney that the kind of container does not have any effect on the recycling rates (NSW, EPA 1994). Since the provision of any type of container would have led to an increase in participation, perhaps a cheaper container could have been supplied instead of the wheelie bin.

While most transportation costs increased, this service successfully managed to keep costs very low in the sector of transporting wastes from the recycling plant to the tip by being located close to it. This implies that some savings in transportation costs can be made from selecting suitable location sites.
a - location of MRF

b - location of tip

Figure 4.1 - Map showing the North and South City division and the site of the tip and MRF (pers Comm, Jones, 1995)
a - location of MRF
b - location of tip

Figure 4.1 - Map showing the North and South City division and the site of the tip and MRF (pers Comm, Jones, 1995)
4.2.5 Demand

Contrary to difficulties expected in finding suitable markets, the Contractor is presently facing no such problem. Recycled goods are presently marketed to 5 different companies. The Contractor established long term contracts with these companies before the service began and is secure about future sales.

Brokers are also getting involved into the business of recycling. For example in the second week of June, 1995, there were 5 calls from brokers regarding newspaper. On an average, Thiess receives about 1 call daily from brokers for newsprint and about 1 per week regarding plastics (pers. comm. Bell, 1995). In most cases, the rates offered by the brokers are higher than the rates offered by the companies but due to the uncertainty in such markets, the Contractor has not dropped the old contracts (pers. comm. Bell, 1995). Presently, the Contractor is considering the option of selling part of the product to these brokers on a short term basis.

The long term contracts and the increase in offers from brokers implies that recycling is expanding. The presence of a choice of market for selling recyclables indicates that markets might not be as big a problem as expected.

4.2.6 Supply

It has been previously stated that supply depends on quality, quantity and price of recycled materials (refer section 2.2.6 ii). The quantity of recycled materials collected has been increasing ever since the service began in July
1994. The supply has increased considerably with the introduction of the service at Shellharbour and Wollandilly. By August 1995, they accounted for almost 40% of the total recyclable material collected (pers. comm. Jones, 1995). Supply quantity does not seem to be a very important consideration in this particular service. It is of course the determining factor in bringing profits for the Contractor, but there is no pressure from the industry to supply minimum amounts to it. This implies that industry may really not be too keen on buying recyclables and is perhaps doing so only because it feels it has to meet up to people's expectations and government goals.

The price for selling materials was determined before the service began through long term contracts with companies. There is no binding order for the Contractor to sell to the company and the Contractor is free to sell to the highest bidder provided it is sold for reprocessing processes and not disposed by the buyer. Hence, while providing the Contractor with the opportunity to sell to anyone who is willing to reuse it, such contracts secure the Contractor from price fluctuations or any losses that could result if the markets were unsteady.

The quality of recycled materials is supposed to be a major problem in recycling. Contamination present is a problem for the Contractor. Most materials are sorted at the MRF so the companies do not normally pose a problem. Sometimes though the contamination amounts are high enough to be unacceptable to companies. This occurred recently in July 1995 in Wollongong when the contamination in glass was too high for the company (ACI Glass) to accept the materials. To solve this problem, the ACI Glass advertised on TV and the radio (pers. comm. Jones, 1995)
4.2.7 Storage

Storage can be a problem, especially if it is long term for the Contractor. Though Thiess does have some storage space it is sufficient only for short term storage purposes.

Figure 4.2 - Sketch of the recycling plant showing storage space.

Thiess has never experienced storage problems with this service. Recycled products are transported to companies every few days or weeks, depending on the material. By the end of every month the Contractor gets rid of all the materials. There even seems to be some competition for certain items like paper and the Contractor is planning to sell to the highest bidder to make profits.
To prevent storage problems at an MRF, it is suggested that markets should be reliable and a system of transporting goods regularly to companies be organised, like in this service.

4.2.8. Balance of Trade

One of the companies that buys recycled goods from the Contractor, namely APM which buys paper and cardboard, has over the past 5 years processed 40,000 tonnes of wastepaper each year. This has replaced about 20,000 tonnes of imported pulp. Some of the paper which is bought by Australian Paper Mills at Botany from the Wollongong recycling plant is exported to Indonesia and China. Thus waste paper that is recycled in Wollongong is exported overseas and brings money for Australia, assisting the balance of trade situation.

A promise of recycling, to favour the balance of trade for the country that recycles, holds true in the case of this recycling program. This indicates that if such a trade structure did develop, recycling could be beneficial to the exporting country.
4.3 SOCIO-POLITICAL

4.3.1 Image

4.3.1.1 Contractor

The Thiess Contractor got into the program for a number of reasons. Among the more important ones was a 'good portfolio' to present for the future (pers. comm. Bell, 1995). Industry, garbage, and recycling are all seen as one big commercial venture to be involved in and present a good image for the company. Being a multinational company, Thiess needed to expand its operations. So far it had no plant in NSW, and involvement in the Wollongong program was a good opportunity for Thiess to present as experience in the field, for the future (pers. comm, Bell, 1995) This was expected to play an important role in attracting future tenders. This has in many ways shown to be effective as the Shellharbour and Wollondilly Council tenders have been won by Thiess. This factor strengthens the idea mentioned in the previous chapter regarding 'image'. It stated that the image aspect was a major reason for a company's involvement in recycling and this case study proves that belief to be right.

4.3.1. ii Government

Like most government bodies relying on public support to remain in office, the Wollongong City Council too has to keep the community happy. Recycling is increasingly considered as the preferred option by the community. So, by being involved in an activity like recycling, the local government is on the right side of people. Several reasons were provided for the start of the service (refer section 3.4.2), image of the local government being one of them. Seeking to uphold its image and taking steps to be on the community's side on the recycling issue, the Council went ahead with this service. This highlights the importance that the image
factor has, along with the indication that community's role in determining such choices are very strong.

4.3.1. iii Industry

For the leading buyers of recycled goods, the fact that they are doing the "right thing" is just as important for them as any other. They agree they recycle because it is the environmentally responsible thing to do and they do not wish to appear irresponsible to the community that they serve. BHP and Comalco - two companies that buy back material have stated their being involved in "environmental matters" as one of the chief reasons for recycling.

4.3.2 PARTICIPATION

4.3.2 .i Society

Society involvement in recycling had been increasing and people stated they would recycle more if provided with a bin (IRIS, 1994). This response from the society provided an indication of the level of interest and motivation already present in the community. The implication of this, for the Council, was that people would perhaps participate if provided with the right kind of service. This went a long way in assisting Council make the decision to provide a new recycling service. This is an indication of the role that society and the community have on recycling.

Though it is realised that the community wished to have the service, it was not clear whether the community realised it's full costs. The $1.7 million that the Council is paying for the service, comes from Government funds which in turn comes from taxes paid by people. If people were given the right to choose and knew the amount of money involved, they would
not necessarily choose the service. To really understand the attitude of the public, perhaps it would be advisable to let them know the full financial costs of the service. It would also make it clear whether people were really going to choose the environment above economic considerations.

4.3.2. ii Individuals

With the introduction of the new recycling service in Wollongong, there has been a marked increase, of about 60%, in the participation rate of the number of people involved in recycling (Wollongong City Council, 1994). It is difficult to believe that people are suddenly becoming environmentally conscious or motivated to do the right thing just in a matter of weeks because as figure 4.3 shows, recycling levels rose drastically with the start of the new recycling service (Wollongong City Council, 1994).

![Figure 4.3 - Amount of recycled material collected quarterly from 1991/92 to 1994/95.](source: Wollongong City Council, 1995.)
The only major difference for the householder between the old and new recycling service was the provision of the new wheelie recycling bin. The provision of the container can thus be taken as the factor that led to increased recycling participation. This strengthens the theory that convenience and reliability play a major role in determining people's involvement in recycling.

Wollongong experienced an increase of approximately 800 households between 1994 and 1995. With an approximate average of 1 tonne of garbage per year, per household, approximately 800 tonnes of increase in garbage amounts could be accounted for. However, garbage has increased by about 5000 tonnes. This increase was thus related to the "extra" space created.

Even though the provision of a bin is expected to be a significant positive factor in increasing recycling participation, the overall increase in garbage amounts, mainly in the form of green wastes can be related to it. This increase is due to availability of more space which is created as a result of removing the recyclables from the garbage bin (where they had been going into previously) to the recycling bin. It is a commonly held belief that householders will use the full capacity of their garbage bins regardless of bin size (NSW, EPA 1994). A 1978 study in Germany showed that "per capita waste generation increases as bin size increases" (Hajek, 1981). It seems that by introducing the recycling bin the Council has created more space for the people to put their rubbish into.
This indicates that for the promises of recycling to really be effective, a simultaneous change in garbage services needs to be exercised. Suggestions for alterations are stated in the conclusion of this chapter.

4.3.3. Source Separation

This increase in recycled material contradicts the theory that monetary rewards are the greatest motivations for people to recycle. There are no monetary rewards for this service but there were monetary rewards for the recycling of aluminium cans prior to the introduction of this service. However, the increase in aluminium quantities from 16.7 tonnes between July-December 1994 to 55.98 tonnes during the same period in 1995, indicates the convenience factor has a greater role in increasing participation than the cash factor. It can be concluded that a convenient and reliable service would perhaps be more effective in increasing participation than one which tries to motivate people through monetary rewards.

Some of the source separation instructions demand that materials be cleaned, crushed etc. This extra effort required of cleaning might put off some people from recycling. Most of the material received at this MRF is dirty and the companies are accepting them. There is also the provision of crushing/bailing at the facility. The following photograph is an example of the acceptance of some contaminated material by the company. It is bailed and ready for transportation to the company. Notice the bottle caps and labels on bottles are present indicating that the company is accepting them like that.
Plate 4.1 - Contaminated Bottles Ready for Delivery.

Hence it is suggested that some of the information that could put off a prospective recycler like "make sure caps are removed", "cans and plastic bottles are crushed and cleaned before putting them in the bin" though ideal, should be avoided as it only puts off people. Perhaps Council should stop promoting ideal recycling practices and concentrate on quantitative recycling rather than qualitative recycling.

4.3.4 Technical

A serious problem that this service faces, and any service might expectably face, is the contamination of recyclables.

There are three different types of contamination from this service:
a) Mixing of non-recyclables with recyclables
b) Mixing of different recyclables
c) Mixing of the different quality similar material eg. different coloured glass.

a) Mixing of recyclables with non-recyclables is done by the public and depends on factors like education and awareness (refer section 4.3.5).

b) Mixing of different recyclables is due to:
i) public putting materials into the wrong divisions.
ii) bin design - There is a small gap at the bottom of the bin between the two divisions which allows paper to slide through into the can/bottle section. This could be rectified by better designed bins with the divisions being all the way through. The following figure shows the gap in the bin which causes co-mingling of materials in the bin.

![Figure 4.4 - Cross-section of the recycling bin indicating the gap at the bottom that causes contamination.](image)

c) truck mechanism - the mechanised arm of the trucks flips open the lid, lifts the bin, tilts it and covers the back section with a flap. However,
when lifting, if the back section of the bin is filled to the top, the weight of the cans/bottles etc. can open the flap and these items fall out into the paper section of the truck till the time that the bin connects with the division in the truck.

This indicates that such mechanised systems are perhaps not as good as the conventional method when materials were separated by hand. Since contamination is often a big issue in recycling it is perhaps advisable to stick with conventional systems rather than expensive mechanical ones. More research could be carried out to make mechanised systems more effective. Better truck designs could improve collection systems in the future.

c) Contamination is also said to result in the processing stage from the mingling of certain differences between products of the same category for example, plastics and glass have to be very carefully sorted since different coloured glass and different grades of plastic cannot be processed together. If technology was suitable for the recycling of these products together, there would be fewer problems for the recycling service as sorting would be easier.

Plate 4.2 shows a picker separate different coloured glass. this separation is essential since no technology exists for reprocessing different coloured glass together.
The points discussed indicate that technology is still very backward in the sphere and much more research needs to be undertaken to enhance recycling.

4.3.5. Awareness and Publicity

4.3.5.i Education

Though little has been stated previously about the relationship between education and participation, this case study shows that there is a direct correlation between them.
There is a marked difference in contamination of recyclables coming from the South of Wollongong in comparison to the Northern part of the city. North and South boundaries being determined by the Council (refer figure 4.1). Since the service covers the Southern area of Wollongong one week and the northern the other, contamination variables could be easily related to areas. The Southern area had 12% more contamination than the Northern. This was calculated on the basis of non-recyclable material collected at the MRF.

This contamination was related to the level of education. Notice in figure 4.5 how graduates, diplomates and certificate holders are concentrated in the Northern part of the city. This difference indicates that higher education levels may have a direct relationship with recycling.

Higher rates of contamination have been observed in the Cringila, Lake Heights and Warrawong area (pers comm Bell, 1995). As fig 4.6 indicates, this area has a high proportion of overseas born population and most residents come from non-English speaking backgrounds. High rates of contamination can thus be related to the lack of knowledge of English. Such an assumption is made because there are no other significant differences between the residents of this area to that of any other with high overseas born populations eg. Dapto (refer figure 4.6). Areas with high percentage of overseas born English speaking populations like Kanahooka, Koonawarra and Dapto do not display the same characteristics in relation to recycling (IRIS, 1986; pers. comm. Bell, 1995).
Figure 4.5 - Distribution of higher degrees of education of the population of Wollongong. Source: Keys and Wilson, 1984
Figure 4.6 - Total overseas population and the English speaking overseas population of Wollongong. Source: Keys and Wilson, 1984
This leads to the conclusion that a lack of knowledge of the language which is used for imparting instructions can have a negative affect on recycling. The Council decision to advertise only in English is seen as a rather inapt policy. Information should have also been printed in major ethnic language newspapers and advertised on the ethnic radio station. Perhaps pamphlets written in ethnic languages could be dropped in selected areas.

4.3.5 ii Publicity

Though the new service began with a massive publicity campaign and advertisements had been more frequent than the previous service, their affect seems to be restricted. This was mainly because of the lack of knowledge of English of several residents of the area having been overlooked by the authorities.

Poor information packages were supplied with the service. The supply of the bin was accompanied with an instruction booklet. This provided detailed information about what could be put into the bin etc. A similar sticker was also stuck on the underside of the lid. However, all this information besides being long and complicated, does not clearly indicate the front and back sections especially when the sticker is put upside down in some cases! The stickers also tend to come off over a period of time, leaving the recycler with no information. Some (not all) bins have 'paper and cardboard only' embossed on one side of the bin but not on the other which does not provide much guidance to the user.
Perhaps the divider could be properly labelled or regular information provided by the Council to clarify the usage for the recycler. Detailed instructions regarding cleaning and washing, though ideal may not be essential and could be ignored in the future (refer section 4.3.3).

However, it was realised that there wasn't enough publicity in Wollongong regarding the service. Calenders with collection dates had been supplied at the start of the service but were only for one year and expired in June 1995. No new information has been supplied for July 1995 onwards. This makes it very difficult for households to know which is the collection week. There is a constant need for sending regular information to households.

Around May 1995 the Council started a competition for a trip to Queensland - a little incentive to keep people motivated and interested and to include some aspect of fun into recycling. Not surprisingly, people were attracted by the offer and amounts increased by about 30% for HDPE (pers. comm. Bell, 1995). Such a method is seen as a good means of encouraging participation and increasing supply. If there is a bleak period in the supply of any material, it is suggested that such steps be taken to increase recovery.

The effect of publicity was obvious in this case study in the context of sharps. Pamphlets were dropped into individual letter boxes imparting information during the first week of November, 1994 and following that, there was a reduction in the number of syringes going into the bin for the next 2/3 months. This leads to the conclusion that publicity and information have a positive effect on recycling in this program.
In July 1995, to reduce contamination in glass, ACI Glass advertised on the TV, radio and newspapers. However, the campaign had little effect on contamination levels. It is concluded from this that such publicity is not effective and it is suggested that letter-box drops be done since they have proven to be more effective.

From the Wollongong experience it was realised that it would be beneficial and essential to have publicity and awareness programs. This indicates that it would be advisable for the agencies involved in recycling to include extensive publicity campaigns for better results.

4.3.6. Employment

There have not been any marked changes in the number of people employed with this service in comparison to the previous recycling service. Though the MRF employs 18 "pickers" for sorting garbage, 14 more than the previous service. The mechanised trucks use 14 less people than the previous service and thus there is no net increase in employment. Previously, besides a truck driver, there were two people manually collecting the goods. Now they are 7 one-man trucks, the driver and the collector being the same person.

In this case, because there was already an existing facility, the effect of the new facility in terms of labour has been reduced. However, when recycling was first adopted, the 25 employees were additions to the workforce. This implies that recycling increases employment.
4.3.7. Health

Though recycling is meant to improve health standards by decreasing the number of people involved in garbage-associated jobs (refer section 2.3.8), not only has this service increased the number of people working in such occupations (refer section 4.3.6), it has actually added a serious health risk for pickers at the MRF.

The presence of used syringes which appear regularly in the co-mingled recyclables has till date (July, 1995) pricked 24 workers as a result of which some have had to go for AIDS checks. On the 17th of June 1995 for example, 270 hyperdemic needles were found by the sorters ad another 80 the next day (Failes 1995). This resulted in the workers threatening to go on strike. To solve the situation, government provided free disposal facilities in 14 pharmacies in Wollongong and did letter box drops. This resulted in a decrease in the number of syringes coming in and the workers felt reasonably comfortable to continue work.

This is a serious health problem and perhaps the pickers should be provided with non-penetrable gloves. More provision for the disposal of syringes around the area could also solve the problem. Perhaps 14 pharmacy drop off centres are not enough. Though the amount going into the bin has reduced, it has not completely disappeared and perhaps it would be ideal to have every pharmacy have the provision of taking back syringes. Increasing publicity about the matter could also add positively to reducing the number of syringes. The possibility of establishing an x-ray machine, though expensive should not be ruled out if it is for the safety of the workers lives (Failes, 1995).
4.3.8. Site Location

The lack of community opposition in the siting of the MRF in Wollongong indicates contrary to popular belief, that it is not always difficult to open such facilities.

The sorting facility is not located near any residential area (refer figure 4.1). The area is also designated for light industrial purposes. Thus it did not take encroach on any residential land that the people could complain about. Also, because of the presence of a garbage tip in close proximity, it is already associated with waste, and the community did not have any opposition about its location.

From the above, it can be concluded that a recycling plant could be suitably located in the vicinity of a tip where people are already used to the area being designated for garbage and do not oppose it as much as they probably would in the case of a new site. Siting on non-residential land is considered wise. Such locations also present some transportational benefits which have been discussed under the economic section of this chapter.

4.3.9. Legislation

The government in 1991 started a Council Recycling Rebate Scheme offering a $20 rebate to Councils for every tonne of recycled glass, paper etc. (NSW, EPA, 1994). It also charges a levy on all tonnes landfilled. However, in Wollongong, the $20 rebate that is offered for the recycled tonne of material is offset against the $4.20 levy that the Councils have to pay the government for every tonne landfilled. It is financially better to not
accept the rebate scheme offered by the government because the $101478.04 ($4.20 times 24161.44 tonnes) to be paid for garbage going into the tip is significantly higher than the $10676.44 ($20 times 5338.22 tonnes) recovered from recycled materials. These rebates may be useful when recycling proportions increase substantially. However it is often at the start of the service that needs the support and encouragement. Government thus needs to readdress is policy to this stage. Lesser rebates could perhaps be offered without levying charges for garbage.

Poor government policy in relation to the disposal of sharps is seen as hindrance to successful recycling. Workers were planning to go on strike in July 1995 when the sharps had increased to dangerous proportions. Special contractors who provide service for the disposal of sharps charge a cost for the service and to avoid such additional costs, people tend to throw them into the recycling bin. Though a service is presently being provided, it can be concluded that if the government had some service for the disposal of syringes in the first place, this problem would not have risen.

Recycling is thus seen as being hampered by poor government policy. It seems as if the government though publicly being in it's favour and encouraging it, is really not doing anything significant towards assisting with recycling.
4.4 ENVIRONMENTAL

4.4.1 Raw Material

Savings of raw materials is one of the most important environmental and economic promises of recycling. This promise was fulfilled by the program in Wollongong when 5338.22 tonnes of materials were collected as recyclables from the service in the first six months of the program (July - December, 1994).

The following table shows the amounts of various materials that were recycled at that time.

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>AMOUNT SAVED (Tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquidpaperboard</td>
<td>27.30</td>
</tr>
<tr>
<td>Aluminium</td>
<td>29.60</td>
</tr>
<tr>
<td>Hdpe</td>
<td>69.43</td>
</tr>
<tr>
<td>Pet</td>
<td>95.49</td>
</tr>
<tr>
<td>Steel</td>
<td>270.50</td>
</tr>
<tr>
<td>Glass</td>
<td>1381.00</td>
</tr>
<tr>
<td>Paper and Cardboard</td>
<td>3465.00</td>
</tr>
<tr>
<td>TOTAL</td>
<td>5338.22</td>
</tr>
</tbody>
</table>


Table 4.1: Materials recycled, July-December, 1994.
The following graph is derived from the above table and indicates the amount and type of raw material collected through recycling in Wollongong.

**Figure 4.7 - Material Recycled, July-December, 1994**

The 5338.22 tonnes collected amount to 18% of the total waste which would otherwise end up in the tip (Wollongong City Council, 1994) and it can be concluded from such savings that recycling conserves resources.

Taking the example of individual materials, the raw material savings from recycling become more explicit. eg for every tonne of cullet used, more than 1.1 tonnes of raw materials are conserved (ACI GLASS). Using cullet reduces the use of raw materials like silica sand, soda ash, limestone. Recycling 1 tonne of aluminium saves approximately 5 tonnes of bauxite (Comalco, pers. comm). All these examples indicate that there is substantial resource saving in recycling.
Before the introduction of the latest recycling scheme, 9% of all wastes were recycled. With 18% of waste being recycled at present, it is obvious that there have been greater savings with the latest recycling service than before. However, the targeted reduction amount as established by ANZECC in 1991 is 50% (ANZECC, 1992). Obviously at this stage, there is further scope for recycling more goods.

4.4.2. Comparison to Other Methods of Waste Disposal

Landfill has for long been the main method of disposing waste in Wollongong. However, with the pressure increasing due to the lack of suitable tip sites in the area (refer section 3.4.2), a certain urgency was felt for reducing the amounts of waste going into the tip. Recycling theoretically is believed to save tip space. This new recycling scheme was introduced by the Council with the hope that it would help fulfil the promise of saving tip space and consequently increase tip life.

Space savings can result from two factors:

i) from the reduction in total waste quantities

ii) from reduction in the amount of cover material used.

Waste quantities decreased during the first six months of the service recycling. Since then, they have been rising. However, the total amount of garbage going into the tip did reduce during the first six months.
TOTAL WASTE COLLECTIONS 1ST HALF OF 1994 (BEFORE THE NEW RECYCLING SERVICE)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>REFUSE</td>
<td>26208.87</td>
</tr>
<tr>
<td>RECYCLING</td>
<td>2550.10</td>
</tr>
<tr>
<td>6 MONTHLY COLLECTION</td>
<td>1415.68</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>30174.65</td>
</tr>
</tbody>
</table>

WASTE COLLECTIONS - 2ND HALF OF 1994 (AFTER THE RECYCLING SERVICE BEGAN)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>REFUSE</td>
<td>23661.32</td>
</tr>
<tr>
<td>RECYCLING</td>
<td>5338.22</td>
</tr>
<tr>
<td>6 MONTHLY COLLECTION</td>
<td>500.12</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>29499.66</td>
</tr>
</tbody>
</table>

Refuse: total garbage from household going into the tip daily
Recycling: total amount of material being recycled
6 Monthly Collection: awkward sized, large amounts of wastes which are collected by the Council once every 6 months from households.

Source: Wollongong City Council, 1995

Table 4.2: Comparison of Total Waste Collections before and after the new recycling service.

The above data corresponds to the following graphs which show that the percentage of recycling has doubled with the new recycling service. The
amount of recyclables have been diversions both from the 6 monthly collection service and the total refuse that enters the tip.

Total waste collection - January to June, 1994.

Total waste collection - July to December, 1994.

Figure 4.8 - Comparison of total waste collections before and after the start of the new service.
Figure 4.4 and corresponding tables indicate that recycling amounts have increased with the new recycling service and materials were diverted from total garbage and hence from going into the tip. Refuse reduced by approximately 3500 tonnes \((26208.87 + 1415.65) - (23661.32 + 500.12)\). This ultimately resulted in saving tip space.

However, after six months of operation around February 1995, it was realised that the amount of garbage was no longer decreasing at a corresponding level with recycling and materials were no longer being diverted from total wastes. There were now increases in overall amounts of waste. As figure 4.8 indicates, there has not been a decrease in the amount going into the tip. The 1995 figures are the same as the 1994 figures even though this service was not available in the first six months of 1994. At this same time, the amount of recyclables being collected is higher than ever before (5676 tonnes). This shows that more waste is being generated.
CONTRACT WASTE DELIVERIES TO WHYTES GULLY


Fig. 4.9
Such an increase in waste quantities prevented any tip space reductions. So, although recycling is still running effectively and collections are increasing, tip space is not being reduced. The reason for this can partly be attributed to the increase in population experienced in Wollongong over the year. 800 new households have come up. On an average every household creates about 1 tonne of waste which would account for approximately 800 tonnes increase. however, 5676 tonnes were recycled with no decrease experienced in the amount going into the tip (pers. comm. Jones, 1995). Thus, it is concluded that more waste has been generated.

ii) Savings in Tip Space due to Reductions in Amount of Cover Material used.

For the first six months of the service, with a decrease in the amount of waste entering the tip, there was a decrease in the amount of cover-slag being utilised. Cover is used for reducing the amount of vermin that are attracted to open waste, litter which flies around, and odours. This decrease in the amount of cover resulted in saving tip space.

In the second half of the year when the new recycling service resulted in a drop in the amount of material from going into the tip, the amount of cover used was also lowered by about 7500 tonnes (Wollongong City Council, 1994). It can be argued that reduction of cover were partly due to the reduction in total waste quantities and not because of the diversion to recycling. A decrease in total waste amounts leads to the decrease in cover material used but in this case the total amount of waste reduced largely because of recycling.
Recycling was responsible for 82% reduction compared to 12% caused due to seasonal fluctuations in total waste quantities. Thus recycling was believed to be the chief reason for the reduction in the amount of cover. This indicates that recycling reduced the amount of waste going into the tip. At the same time, since the amount of cover and incoming waste quantities are directly related, the amount of space cover increased with the increase in wastes between January and June, 1995 (Wollongong City Council, 1995)

This service indicates that though recycling can result in saving tip space, this effect may be a short-term one, and recycling may not be successful in fulfilling the promise of tip space reduction.

4.4.3. Energy

A significant amount of energy is saved during production from the use of recycled goods compared to virgin materials. Whether this reduction is significant enough to affect overall energy consumption, is difficult to determine because it involves complicated equations between transport energy, machinery energy, industrial energy etc. which are outside the scope of this thesis. However, from information received from industries, a reasonable amount of energy is saved in the production process of recycled materials in comparison to virgin materials. The following table gives the figures of the amount collected

95
### Table 4.3: Percentage of energy saved as a result of using recycled material.

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>AMOUNT OF ENERGY SAVED (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>75 (a)</td>
</tr>
<tr>
<td>Aluminium</td>
<td>95 (b)</td>
</tr>
<tr>
<td>Glass</td>
<td>25-35 (c)</td>
</tr>
</tbody>
</table>

Source (Industry Estimates):

a) BHP Steel, 1994  
b) Comalco, 1995  
c) ACI Glass, 1992

These figures match targeted rates established in the previous chapter (refer table 2.4). It can be concluded that recycling comes up to expectations in this case.

### 4.4.4. Contamination

Much of the reduction in contaminants is related to the tip space savings eg. reduction in the amount of leachate, ground water contamination, methane gas reduction. With there being no tip savings presently in this service, reductions in such contaminants is probably not present. A change in composition in waste can alter the amount of contamination but with no significant reductions in waste amounts this is a highly optimistic outlook and perhaps not justified. Thus another promise of recycling has not been accomplished.
4.4.5. Noise Pollution

Noise was theoretically expected to be a problem more from the plant than the truck. While there have not been any complaints about the plant noise, probably due its isolated location, truck noise seems to have been a problem in this area. The reason for this can be attributed to several factors:

i) There are now two collections - one for garbage and one for recycling.

i) The trucks are mechanically operated and have to go on both sides of the street to collect the recycling bin from the kerbside. Earlier, the collection was done manually and the truck went through the streets only once (refer plate 4.3)

iii) These recycling trucks result in higher noise levels than the previous trucks because the glass which is collected is dropped into the truck from a height, into a compartment often with some glass from the previous households, resulting in loud breakage noise. This tends to make a much louder noise in comparison to manual collection which did not involve this dropping.

iv) The mechanised arm tends to make noise too, something that did not occur in the earlier recycling service.
Plate 4.3 - Mechanised arm leading to single side collection from kerbs.

Thus though house-to-house collection is considered as the most favourable option, it is realised through his service that mechanised collection systems can result in noise pollution. Perhaps more research needs to be done on improving the truck design because the problem of noise from the MRF can easily be solved by careful selection of a site, as in this case study.
4.4.6. Site Location

Though major socio-political and economic problems associated with siting were overcome in this particular case, there were some environmental factors that had not been taken into consideration.

The land has numerous alternative uses which have been foregone as a result of it being used as a recycling facility. Though such alternative uses are not tangible and not necessarily economic eg. loss of natural fauna and flora and soil, yet they are environmental losses.

Plate 4.4 - Location site prior to establishment of the MRF

Plate 4.5 - Location site after establishment of the MRF.
As Plate 4.4 and 4.5 indicate, the area was once open land with natural grass. It was part of the aesthetic landscape and has now been replaced by a built-up structure.

This indicates that recycling can have a negative effect on the environment and due consideration would have to be given in the future to prevent environmental damage.

4.4.7. Ecological

From the Plates above, it is obvious that it is a grass area, perhaps, not naturally suited for trees. However, following Council policy of having landscape plans, the Council and Contractor did some hydroseeding of native trees and grass. Though this might be looked upon as being environmentally constructive, it may not necessarily be so. It is a widely acknowledged fact that replanting an area with other plants can disturb the ecology of the region and be more harmful for the environment. The planting has however been unsuccessful and new ways of planting are being considered (pers Comm. Jones, 1995).

The location of any plant on a piece of open land would expectably result in some ecological interference in the environment. What is implied is that care must be taken to ensure that environmental planning is carried out and given significant importance, not only in plans (as seems to have happened in Wollongong) but in reality.
4.5 CONCLUSION

This case study resulted in some interesting findings. Among them, the increase in waste quantities, the failure of the service to reduce waste quantities going into the tip, the contamination, and successive failure of mechanised service, the health problem for workers associated with syringes, the success of a suitable location site of a MRF and the relation of education and awareness to recycling attitudes were the most interesting.

It was found that with the new recycling service in Wollongong, though recycled goods are collected in large quantities, there are no corresponding reductions experienced in the amount of waste going into the tip. While other explanations were considered, it was concluded that the provision of the recycling bin had actually resulted in increasing the amount of wastes generated by the people because of more space being available in the bin. It is suggested that for recycling to be successful, along with the provision of the recycling bin, the size of the garbage bin should be reduced. This could increase expenditure for the Council but other benefits might be greater in the long run.

An alternative suggestion is to reduce garbage services. Garbage collection services could be reduced to once a fortnight rather than once a week. This would also have other advantages. It would reduce expenditure on transport, make people consider composting or reduction, as less bin space would be available and perhaps make it easier for people to remember which is collection week. Presently recycling is collected every fortnight and garbage every week. This adds confusion for the householder as to which is garbage-only day and which is recycling and garbage day. However, such
reduction in service would have to be accompanied by a big explanatory campaign because people would probably think they are getting less service for their rates. A delayed collection would also increase vermin and smell.

Another way to discourage waste generation would be for the government to introduce 'user pays' charges. Households would have to pay according to the amount of waste they generated. More garbage would result in higher costs for the households. This could motivate people to recycle more. However, the government is likely to lose popularity by introducing charges.

Thus it is concluded that the best solution would probably be to reduce the size of the garbage bin. Size reduction along with huge fines for larger bins has resulted in reducing the amount of waste ending up as landfill by 42% in North Sydney (Reeves, 1995)

It is also understood that the main component of this increase in waste quantity is compostable waste. This ends up filling the left-over space in bins as people avoid leaving green wastes in their backyards. These also add to the pollution at the tip and attract vermin etc. To overcome this problem, it is suggested that a separate bin be provided for compostable waste and a service be provided for its collection. This bin need not be as large in size as the recycling bin. It could have a different coloured lid, maybe green to indicate green waste and to be different from the yellow recycling bin. Perhaps the compost collected could be used to start a farm near the tip for fresh vegetables. This would not only reduce the amount of rubbish from going into the tip but would reduce pollution and provide
fresh vegies for the neighbourhood. This has been successfully been adopted in Calcutta in India. Vegetable farms were started on compostable wastes. These not only reduced the amount of garbage going into the tip, but provided fresh vegetables for the city dwellers, simultaneously reducing the volume of the waste rapidly.

Since the success of recycling depends to a great extent on people's attitudes, educational and publicity campaigns are important. These should not be selective and should cater to all people of the community, unlike in Wollongong where they are only in English and not understood by a large proportion of the population which comes from non-English speaking backgrounds and cannot understand the instructions. This brought forward a very interesting idea regarding the relation of understanding of instructions and the level of education to recycling habits. People from non-English speaking backgrounds did not recycle as well as the people who did understand the language. Also graduates and higher degree holders seemed to have better recycling habits.

Thus it is suggested that target audiences need to be identified and publicity campaigns directed to their level. For example, for lesser educated people, perhaps more pictorial rather than textual instructions could be provided. Instructions in the present booklet are a bit complicated eg. "no waxy paper", only bottles marked '1', '2', '3' etc. It does not for example say that the '1, 2 or 3' could be found at the bottom of every bottle. Maybe pamphlets with simple instructions could be dropped more regularly. There is also a need to have information printed in different languages and perhaps publicity in ethnic newspapers and radio stations could prove to be
a more effective means of imparting information for the ethnic populations.

There is also the need to have regular letter-box drops as they seem to be more effective than other form of promotional propaganda. Though the Council has used this method of promotion effectively in specific cases like with syringes,

it has not done so for other information. The lack of regular information seems to be hampering the service and it is suggested that the Council routinely carry-out letter-box drops of all information from time to time. With the start of the service, a sticker was provided stating the recycling week for the household. This helped people know when to put their bins out for collection. This calender expired in June 1995 and another one has not been provided. This can lead to a loss of interest for the householder and reduce participation. It is suggested that Council provide households with stickers for this year and keep up the provision of such a calendar each year for the convenience of the household.

It is not very clear why the service has so many strict instructions for the public to follow. "make sure to remove all tops from bottles", "wash jars" "flatten cans" etc. These can put people off as it implies too much "extra" work just to throw rubbish. There is a baling/crushing facility at the MRF and as seen in plate 4.1. Bottles received have tops and labels on and jars too tend to not be very clean. The industry is still buying them because the level of contamination is acceptable. When the industry is willing to buy materials with a little contamination and there is the facility to crush and bale the cans and bottles, it is not clear why the public is asked to do so. Some people might find it easier to just throw their recyclables in a bin
rather than clean and wash them. Thus recycling might be encouraged in some cases by eliminating instructions that can put people off involvement.

The Wollongong program did not have any sort of community involvement in the decision-making aspect of the program. Individuals participate through separating recyclables and putting their bins out for collection but have no other form of involvement with the service. It is suggested that people and voluntary organisations involved in environmental matters be invited to attend meetings or Council invite them for suggestions. This would increase enthusiasm and participation. Council could provide incentives for increasing recycling amounts - perhaps in the form of something environmentally beneficial to the locality that recycles the maximum. This would induce people of the area to come together and perhaps get more people involved with the service.

More advertisements in public areas and more importantly the provision of recycling bins in public places like shopping malls, beaches, parks could increase involvement and should be allocated at the beginning of every new recycling service. They could be made mandatory in schools and universities. These bins should be placed close to garbage bins which would perhaps make it easier for people to dispose their recyclables and avoid contamination that could result if the recycling bins were placed somewhere else and be considered as ordinary garbage bins.

Service should also be more predictable. In Wollongong, collection time changes with the driver. Thus, some households used to a certain time
of collection might miss the service if there is a change of drivers. Why would one want to put their bin out the night before or leave their bin out all day if the service is provided only at 3 pm and someone could put it out at that time? To avoid this perhaps all drivers could be provided with instructions to follow the same route pattern for the area. In this way, the service would appear to be more reliable and predictable and easier for the people to adjust their time with it.

Contamination is another problem associated with recycling. There were a number of reasons for contaminants entering the recycling stream in Wollongong. Though some contamination could be attributed to lack of understanding by the public, it was concluded that it was mainly due to technical reasons by the faulty design of the bin and the collection system of the truck.

It was realised that perhaps it is not as beneficial to have sophisticated, expensive equipment since conventional systems result in less contamination. The mechanised trucks also create more noise than the previous service. Though noise pollution could be reduced in these trucks by sheeting so that bottles do not crash and break, it is realised that the service would be more efficient if carried out manually.

Certain items like cardboard cannot be picked mechanically if jammed into the bin. Such difficulties did not arise in the case of manual collection. No boxes needed to be flattened and dismantled into smaller pieces so that they would not be left behind in the bin. Manual collection would also assist in locating households with poor recycling habits and perhaps reduce health risks, since smaller quantities would be handled at a
time. However, manual collection can increase costs if labour is expensive. Manly in Sydney is paying heavily for workers compensation because of the injuries caused to workers from lifting bins (pers. comm. Jones, 1995). Mechanisation has added to noise pollution and failed to reduce labour as promised since collectors have been replaced by pickers at the MRF.

Running costs of MRFs are high and the returns from recycled material are not enough to cover all costs. The Wollongong service is not making any profits. It is able to carry on operation only because it is established in conjunction with the total garbage facility and not dependent on just returns from recycling to carry on. Such a combination with total garbage is seen as an important learning experience from this case study. It lowers the risk factor for the Contractor during the first few years of the service and it is hoped that with an increase in the scale of operation, returns will increase and the service will reap some benefits in the future.

Though this operation appears to have no difficulty in marketing the recycled goods because of the long term contracts that the Contractor had established with the companies even before the start of the service. This prerequisite of establishment of contracts with companies, for the submission of the tender, was a very wise decision made by the Wollongong City Council.

Another positive element of this service to be taken as an example to be followed was in the location of the MRF site. It is located close to the garbage tip, away from residential area, in a land designated for light industrial purposes. Due to these factors it managed to avoid expected social opposition. The site also resulted in saving some transportation costs by being close to the tip, for wastes did not have to transported far. It is thus
concluded that such sites would be ideal for the location of MRFs and should be considered in the future.

It is however not a complete evaluation. Some factors that would be significant were left out because of lack of information, or the nature of this particular service. For example, changes that might have resulted in employment by the introduction of such a service, the cost of the initial establishment and the return from recyclables etc. though of interest, could not be evaluated in this study. These would perhaps be of interest in other case studies where such information can be collected. Suggestions made for this service need to be reviewed in detail and their economic, socio-political and environmental promises and problems estimated.
CHAPTER 5: CONCLUSION

Though the initial aim of the thesis was to assess the suitability of recycling as a method of waste disposal, the establishment of a comprehensive framework was considered essential prior to evaluation of the method. A broad framework was hence incorporated in this thesis to provide a more comprehensive background for the evaluation.

While establishing the framework, it was realised that the three main factors that affected recycling - economic, socio-political and environmental, were closely related to each other and incomplete when considered in isolation from one another. A complete picture of recycling could only be obtained when all factors were given full consideration. It was concluded that assessing recycling on the basis of any one factor would present a very narrow and incomplete evaluation.

The historical aspect of recycling was discussed briefly and helped to provide a better perspective on local council decisions made regarding the method. It provided the background for a better understanding of recycling by explaining reasons for its introduction.

The suitability of recycling was then assessed by a case study of the current Wollongong Domestic Waste Recycling Program. By means of this case study some guidance for future recycling was acquired. Among the findings, the need to introduce a change in garbage services simultaneously with the start of recycling seemed to be the most important. The failure of certain promises of the Wollongong Service could be attributed to the lack of alteration in garbage services. It is suggested that future recycling services
make a corresponding change in garbage services either by reducing bin sizes or reducing collection. It is also suggested that future recycling services be contracted together with the garbage service as recycling in itself is presently not self-sufficient in most cases. This could provide the financial backing that recycling needs till the scale increases to become more profitable or markets become more competitive.

The importance of regular information and publicity was also stressed because of the failure of the Wollongong service to effectively do so. Increasing community involvement in decision-making and introducing government legislation in favour of recycling could also be considered in the future. This service seems to have successfully dealt with the problem of markets and most problems associated with the location of the MRF. The establishment of long-term contracts for the sale of recyclable goods and location of a MRF near a tip in a non-residential site could be a model for future services.

Though many of the factors discussed above are relevant to Wollongong only, they make an important point - that small local factors have to be taken into consideration before the adoption of the service. Every area is individual and though most promises or problems would be common to many areas, there is a indication that local conditions would have a strong influence eg. the failure of advertising only in English in Wollongong. It is also realised that there can never really be any "right" way for recycling which is valid to all nations. Each area will have individual conditions and they will have to dealt with individually.

Being localised, broader international aspects of recycling such as international relations, though established in the framework cannot be key
concerns for local recycling services like Wollongong. They are of concern on a larger scale, for example in the context of a whole country. Since Australia does have a National Recycling Strategy, it would be interesting to see how recycling affects relations between countries. This however lies outside the scope of this thesis and is left open for future research.

This is only one case study and while it does substantiate the factors that are previously discussed as problems and promises, it is not to be regarded as conclusive proof or evidence of any factor but as more advancement in the sphere of domestic solid waste recycling. Only further research could provide a conclusive basis for the establishment of a "theory of recycling", if ever there can be one.

The failure of recycling to meet some promises leads to the conclusion that though recycling is gaining importance at the present time and will probably be promoted strongly in coming years, it may not really be a long term solution. Taking the example of Japan for instance which has a very sophisticated and efficient recycling system but recycles only 50% of all waste and is unlikely to be able to recycle more (Corson, 1990). This is because after a stage the costs of recycling outweigh the benefits. When such a position is reached, it is believed that other methods like waste minimisation will gain greater importance. It is already considered the preferential method of solving the waste problem (refer fig. 3.3)

Recycling is thus one option for waste disposal and though it will not cease to exist in the future, it will probably decrease in importance after 20-30 years. If present trends continue, society is likely to move towards an integrated waste management system and recycling then will become part of a larger system of waste management including waste minimisation.
incineration, landfill and other methods (Van Dam, 1978). However, this is left open to be researched in the future.
REFERENCES


ACI Glass. (1992) - Glass Packaging and the Environment. (information brochure)


____(No Date) - Steel Can be Used Again and Again. Information Brochure


Commerce and Trade Department and the Western Australia Municipal Association. (1993) - State Recycling Blueprint - A Plan To Halve Waste to Landfill in WA by the Year 2000.


Failes, Geoff (1995) - "HIV Fear Needles Recycling Workers", Illawarra Mercury. 20th June,


IRIS (Illawarra Regional Information Service) (1994) - Wollongong City Council Community Survey. IRIS


120


UNESCO. - All of Us. No.11, Environmental Education Dossiers. July 1994


Wollongong City Council (1978) - Submission for the Minister for Planning and Environment's Pollution Abatement Award, 1978.


(1994) - Contract between the City Council and Thiess.